United States Air Force
611th Air Support Group/
Civil Engineering Squadron

Elmendorf AFB, Alaska

Final

Risk Assessment

Oliktok Point Radar Installation, Alaska

Prepared by:

ICF Technology Incorporated

15 APRIL 1996

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PREFACE

This report presents the findings of Risk Assessments at sites located at the Oliktok Point radar installation in northern Alaska. The sites were characterized based on sampling and analyses conducted during Remedial Investigation activities performed during August and September 1993. This report was prepared by ICF Technology Incorporated.

This report was prepared between January 1995 and April 1996. Mr. Samer Karmi of the Air Force Center for Environmental Excellence was the Alaska Restoration Team Chief for this task. Dr. Jerome Madden and Mr. Richard Borsetti of the 611th CES/CEVR were the Remedial Project Managers for the project.

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ICF Technology Incorporated

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NOTICE

This report has been prepared for the United States Air Force (Air Force) by ICF Technology Incorporated for the purpose of aiding in the implementation of final remedial actions under the Air Force Installation Restoration Program (IRP). As the report relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the IRP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate. Acceptance does not mean that the United States Air Force adopts the conclusions, recommendations or other views expressed herein, which are those of the contractor only and do not necessarily reflect the official position of the United States Air Force.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADD	Average Daily Dose
Air Force	United States Air Force
ARAR	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
BCF	Bioconcentration Factors
CDI	Chronic Daily Intake
COC	Chemical of Concern
DEW	Distant Early Warning
DRPH	Diesel Range Petroleum Hydrocarbons
ECAO	Environmental Criterion Assessment Office of EPA
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ha	Hectare
HEAST	Health Effects Assessment Summary Tables
HQ	Hazard Quotient
HVOCs	Halogenated Volatile Organic Compounds
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IS	Onsite Dietary Intake
LADD	Lifetime Average Daily Dose
LOAEL	Lowest-Observed Adverse Effect Level
LOEL	Lowest Observed Effect Level
MDEP	Massachusetts Department of Environmental Protection
NOAEL	No Observed Adverse Effect Level

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

NOEL	No Observed Effect Level
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
ppm	Parts Per Million
RBSLs	Risk-Based Screening Levels
RfD	Reference Dose
RIs	Remedial Investigations
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
SF	Scaling Factor
SVOCs	Semi-Volatile Organic Compounds
TPH	Total Petroleum Hydrocarbon
TRVs	Toxicity Reference Values
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
VOCs	Volatile Organic Compounds
UCL	Upper Confidence Limit
UF	Uncertainty factors

1.0 INTRODUCTION

This document contains the baseline human health risk assessment and the ecological risk assessment (ERA) for the Oliktok Point Distant Early Warning (DEW) Line radar installation. Eight sites at the Oliktok Point radar installation underwent remedial investigations (RIs) during the summer of 1993. The presence of chemical contamination in the soil, sediments, and surface water at the installation was evaluated and reported in the Oliktok Point Remedial Investigation/Feasibility Study (RI/FS) (U.S. Air Force 1996). The analytical data reported in the RI/FS form the basis for the human health and ecological risk assessments. The primary chemicals of concern (COCs) at the eight sites are diesel and gasoline from past spills and/or leaks, chlorinated solvents, metals, and polychlorinated biphenyls (PCBs). The general location of the Oliktok Point radar installation is shown in Figure 1-1. The eight sites investigated and the types of samples collected at each site are presented in Table 1-1.

The purpose of the risk assessment is to evaluate the human health and ecological risks that may be associated with chemicals released to the environment at the eight sites investigated during the RIs. The risk assessment characterizes the probability that measured concentrations of hazardous chemical substances will cause adverse effects in humans or the environment in the absence of remediation. The risk assessment will be used to determine if remediation (site cleanup) is necessary and, if so, to rank sites for remedial action.

1.1 ORGANIZATION OF REPORT

Section 1.0 contains introductory information regarding the installation location and conditions, and a summary outline of the approach to the human health and ecological risk assessments. Section 2.0 is the Baseline Human Health Risk Assessment, and Section 3.0 is the Ecological Risk Assessment. References are presented in Section 4.0. Section 2.0, Baseline Human Health Risk Assessment, is composed of:

- **Selection of Site Contaminants**. Presents the COCs for human health and describes how they were selected for this risk assessment.
- **Exposure Assessment**. Identifies the pathways by which potential human exposures could occur, and estimates the magnitude, frequency, and duration of those exposures.
- **Toxicity Assessment**. Summarizes the toxicity of the selected COCs and the relationship between magnitude of exposure and the development of adverse health effects.
- **Risk Characterization**. Integrates the toxicity and exposure assessments to estimate the potential risks to human health from exposure to chemicals in environmental media.

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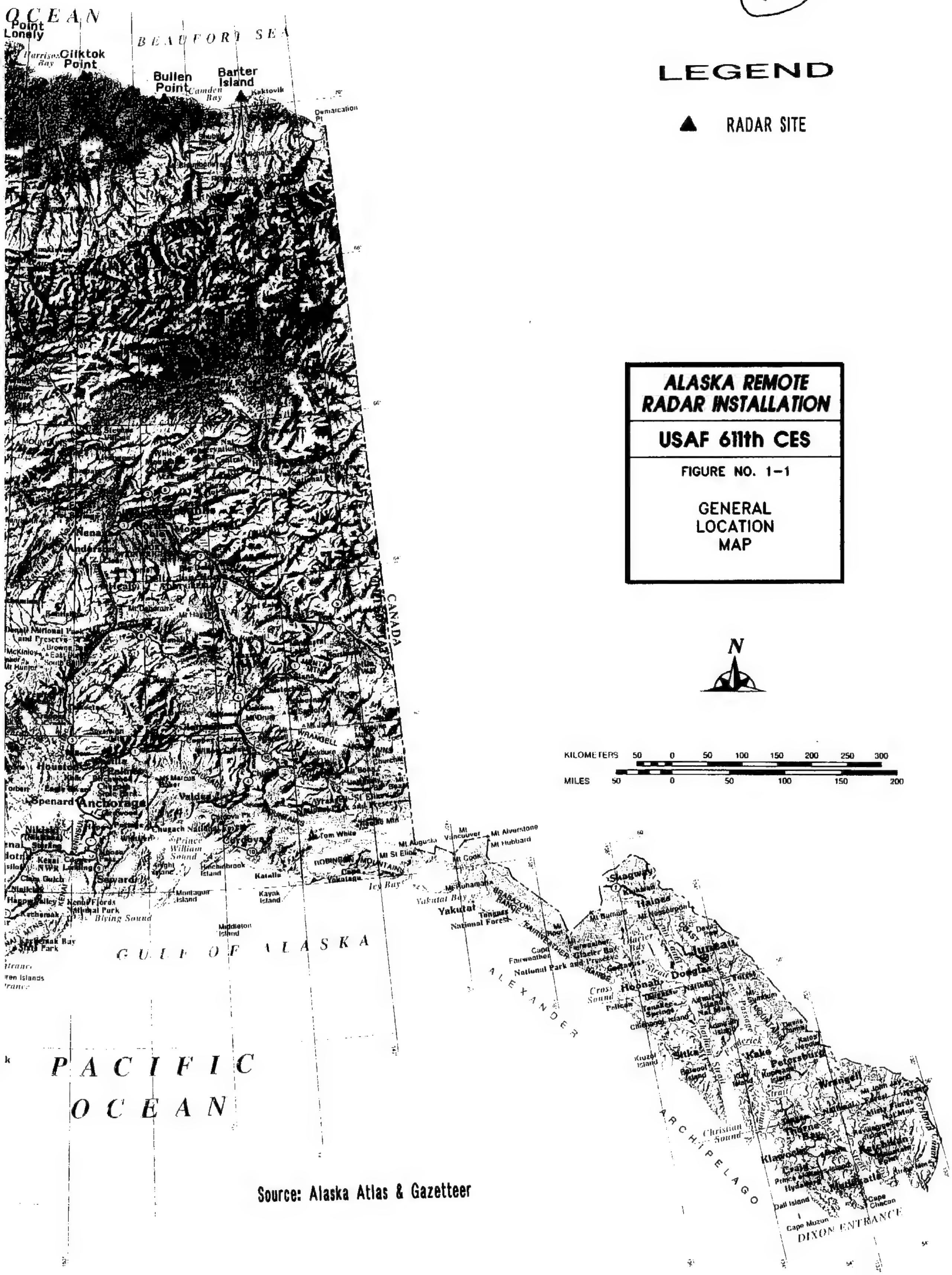
1

ARCTIC OCEAN
Barrow
Point Barrow
Dease Inlet
Wainwright
Peard Bay
Smith Bay
Point Lonely
Harrison Bay
Oliktok Point
Bullen Point
Icy Cape
Point Lay
Cape Lisburne
Point Hope
Alaska Maritime National Wildlife Refuge
CHUKCHI SEA
RUSSIA
UNITED STATES
Kivalina
Cape Krusenstern National Monument
Kotzebue
KOTZEBUE SOUND
Cape Espenberg
Shishmaref
Big Diomede Island
Little Diomede Island
STRAIT
Cape Prince of Wales
Wales
Deering
Candle
BERING
King Island
Port Clarence
Teller
SEWARD
PENINSULA
Cape Douglas
Gambell
Savoonga
SAINT LAWRENCE ISLAND
Nome
Cape Nome
Norton Bay
NORTON SOUND
Stuart Island
Stebbins
Saint Michael
Unalakleet
BERING SEA
Emmonak
Alakanuk
Pastol Bay
Scammon Bay
Cape Romanzof
Hooper Bay
Chevak
Saint Matthew Island
Hazen Bay
Mekoryuk
Nelson Island
Nunivak Island
Etolin Strait
Baird Inlet
Bethel
Kipnuk
Quinhagak
KUSKOKWIM BAY
Goodnews Bay
Platinum
Cape Newenham
Togiak Bay
Hagemeister Island
Cape Constantine
Kvichak Bay
Iliamna Lake
Augustine Vol
Kennedy Entrance
Barren Islands
Stevenson Entrance
Saint Paul Island
Saint Paul
PRIBILOF ISLANDS
Saint George
Saint George Island
BRISTOL BAY
Pilot Point
Port Heiden
Wide Bay
SHELIKOF STRAIT
Kodiak
Kodiak National Wildlife Refuge
Sitkinak Strait
Trinity Islands
PACIF
OCEA
GULF
Anchorage
Spenard
Houston
Kenai
Soldotna
Homer
Seldovia
Anchor Point
Seward
Blying Sound
Kenai Fjords National Park
Denali National Park and Preserve
Mt McKinley
Herendeen Bay
Mt Veniaminof
Chignik Bay
Sutwik Island
Perryville
Semidi Islands
Chirikof Island
Izembek National Wildlife Refuge
Cold Bay
Unimak Island
Unimak Pass
Ikatan Bay
King Cove
Sand Point
Stepovak Bay
Unga I
Nagai I
Shumagin Islands
Sanak Islands
Deer Island



LEGEND

▲ RADAR SITE

ALASKA REMOTE RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 1-1

GENERAL LOCATION MAP

N

KILOMETERS 50 0 50 100 150 200 250 300

MILES 50 0 50 100 150 200

Source: Alaska Atlas & Gazetteer

TABLE 1-1. SITES EVALUATED AT OLIKTOK POINT DEW LINE INSTALLATION

SITE NAME	SITE ID NUMBER	SOIL	SEDIMENTS	SURFACE WATER
Old Landfill	LF01	X	X	X
Dump Site	LF02	X	X	X
Dock Storage Area	ST03	X	X	X
POL Storage	ST04	X	NA	NA
Diesel Spill	SS05	X	X	X
Gasoline Storage Area	ST08	X	X	X
Garage	SS10	X	X	X
Old Sewage Area Petroleum Spill	SS11	X	X	X

X Chemical analyses were performed on these media.
NA No chemical analysis was performed.

- **Risk Characterization Uncertainty**. Describes the potential shortcomings in the data and the methods used to develop the risk assessment, and the uncertainties in the interpretation of the data and the risk characterization results.

- **Risk Assessment Summary and Conclusions**. Presents a summary of, and conclusions regarding, the potential human health risks associated with exposure to contaminated media at the eight sites at the Oliktok Point DEW Line installation.

Section 3.0, the Ecological Risk Assessment (ERA), is composed of:

- **Selection of Site Contaminants**. Presents the COCs for ecological receptors and describes how they were selected for the ERA.

- **Ecological Exposure Assessment**. Identifies the potential receptors and representative species, habitat suitability, and exposure pathways.

- **Ecological Toxicity Assessment**. Describes the potential effects of site contaminants on the representative species.

- **Risk Characterization for Ecological Receptors**. Evaluates the likelihood of adverse effects on ecological receptors.

- **Ecological Uncertainty Analysis.** Describes the potential shortcomings in the data and methods used to develop the ERA, and the uncertainties in the interpretation of the data and the ecological risk characterization results.

- **Summary of Ecological Risks.** Presents a summary of ecological risks associated with the eight sites at the Oliktok Point DEW Line installation.

Appendix A contains the human health risk assessment spreadsheets used to estimate chemical intake, noncancer hazard, and excess lifetime cancer risk. Appendix B consists of toxicology profiles. The exposure equations and calculations for ecological receptors are presented in Appendices C through F. Appendix G contains a summary of RI sampling and analyses, and the RI analytical data for all sites from which the COCs were selected and upon which the human health and ecological risk assessments are based.

1.2 RISK ASSESSMENT GUIDANCE DOCUMENTS

The following guidance documents were used to develop the human health and ecological risk assessments:

- *Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual (Part A)* (EPA 1989a);

- Region 10 Supplemental Risk Assessment Guidance for Superfund (EPA 1991a);

- *Risk Assessment Guidance for Superfund: Volume 2, Environmental Evaluation Manual* (EPA 1989b);

- General Guidance for Ecological Risk Assessment at United States Air Force (Air Force) Bases (MITRE 1990);

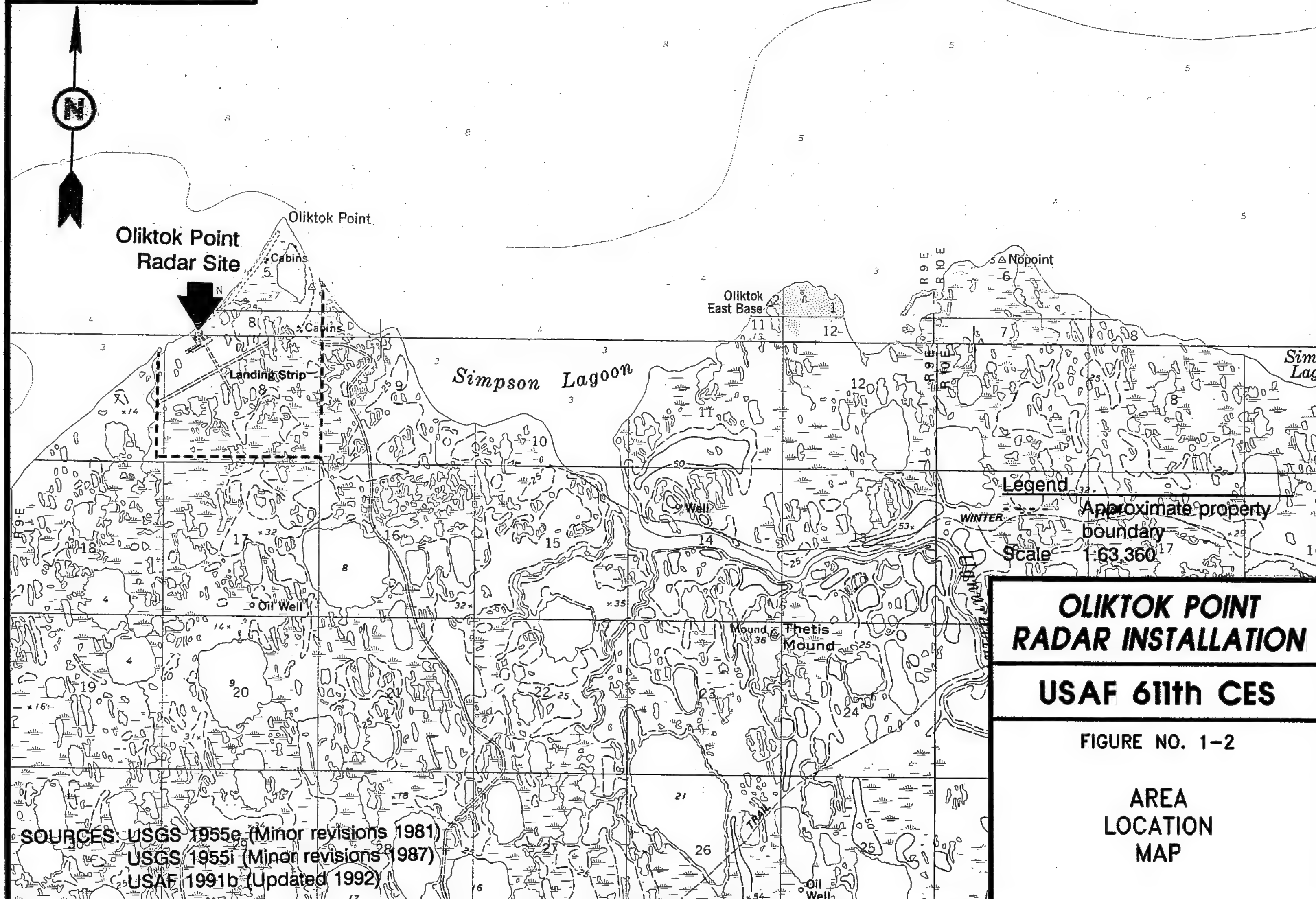
- Handbook to Support the Installation Restoration Program (IRP) Statements of Work (U.S. Air Force 1991); and

- Framework for Ecological Risk Assessment (EPA 1992a).

1.3 INSTALLATION DESCRIPTION AND ENVIRONMENTAL SETTING

The Oliktok Point DEW Line installation is located at 70°30'N, 149°53'W on Oliktok Point, east of the Colville River on the north coast of Alaska. The installation occupies 2,325 acres approximately 30 miles from Nuiqsut, the nearest community, and approximately 40 miles from Prudhoe Bay/Deadhorse. An area location map is presented in Figure 1-2, and an installation site plan is shown in Figure 1-3.

DRAWING No. OLI-AREA



OLIKTOK POINT RADAR INSTALLATION

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FIGURE NO. 1-2

AREA LOCATION MAP

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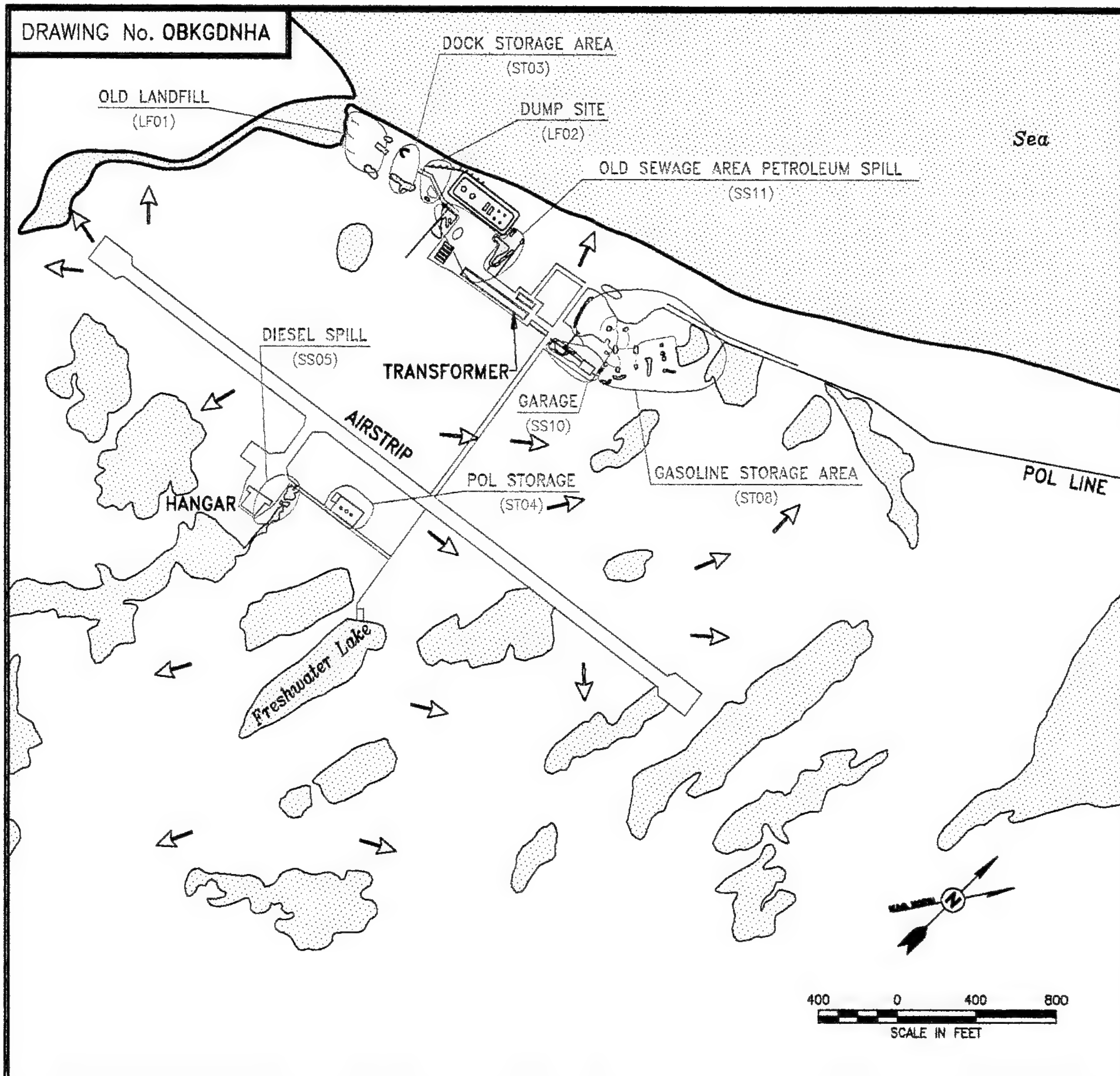

FIGURE NO. 1-3

INSTALLATION
SITE PLAN

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The Oliktok Point installation was constructed in 1954 and 1955 as an auxiliary DEW Line station consisting of one 25-module train, radome, and support facilities. The installation now consists of a module train containing living quarters, a power generation plant, sewage and water systems, and an incinerator. The radome is built on a steel-framed platform that straddles the module train. The installation also has a 4,020-foot-long lighted gravel runway.

Geology and Geography. Geologically the area consists of surficial deposits of silty loam and an organic layer called a tundra mat that provides an insulating barrier between the air and the underlying perennially frozen ground. The area is underlain with shallow medium to fine-grained sands and silts. Permafrost underlies the entire installation.

Permafrost comprises geologic, hydrologic, and meteorologic characteristics that result in permanently frozen ground. Permafrost occurs in both unconsolidated sediments and bedrock. Its distribution is continuous on the Arctic Coastal Plain, and it has a significant impact on the flow of ground and surface water.

Permafrost acts as an impermeable barrier to the movement of groundwater because pore spaces are ice-filled in the zone of saturation. Recharge and discharge are limited to unfrozen channels penetrating the permafrost zone. Permafrost restricts the downward percolation of water and increases runoff, enhancing the creation of lakes and swamps, and also restricts an aquifer's storage capacity and the number of locations from which groundwater may be withdrawn.

The interval between permafrost and ground surface is called the active zone because it freezes and thaws with seasonal weather changes. Water may be found in the active zone in the summer months. The thickness of the active zone at Bullen Point varies from approximately one to six feet.

The local geography includes numerous small lakes, ponds, and other areas of standing water. At the installation, the tundra mat and silts have been removed or destroyed, and gravel has been placed over the older sediments to provide a foundation for the structures identified above.

Meteorology. Temperatures at Oliktok Point are generally low throughout the year, with the absolute minimum and maximum being -58°F and 78°F (Hart Crowser 1987). Annual precipitation at the Oliktok Point installation averages 4.9 inches, including 27 inches of snow. Most precipitation occurs in July and August; precipitation in October to May is mostly snow. Strong westerly winds are common during the winter.

Demographics. On average, two people are stationed at the Oliktok Point installation on a regular basis. The closest village is Nuiqsut, which is approximately 30 miles southwest of the installation and has a population of 418 (Harcharek 1994). Air travel provides year-round access, as does a gravel road system that connects to the Prudhoe Bay/Dead Horse area and the Dalton Highway. Seasonal marine transportation is provided by an Air Force contract carrier.

Historically, the area along Simpson Lagoon, just east of the installation, has been used for subsistence activities with yearly and seasonal variations influenced by the availability of

resources (Hart Crowser 1987). The Oliktok Point installation is within the subsistence use area of the village of Nuiqsut and also may be used by natives of the North Slope from as far as Kaktovik (NPRA Task Force 1979). Although subsistence studies have not been conducted for the area, available resources are known to include sea mammals, caribou, fish, and migratory waterfowl.

Almost no recreational activity occurs at or near Oliktok Point because of the isolated location. Access is difficult and no public services are available. Recreational activities of the residents of Nuiqsut and workers at Prudhoe Bay/Deadhorse are generally limited to the general vicinity of the village and work areas. Some boat trips and backpacking occur at the Colville River (NPRA Task Force 1978).

The Oliktok Point DEW Line installation was investigated to evaluate possible contamination related to Air Force activities and historical waste disposal practices at the sites. Eight sites at the installation were determined to be of potential concern based on previous IRP sampling activities, literature searches, pre-survey and reconnaissance trips, interviews with station personnel, and information on disposal practices at DEW Line installations. The sites were investigated during RI/FS activities to confirm the presence or absence of chemical contamination; define the extent and magnitude of confirmed chemical releases; gather adequate data to determine the magnitude of potential risks to human health and the environment; and gather adequate data to identify and select the appropriate remedial actions for those sites where apparent risks exceed acceptable limits. The remainder of this section describes the eight sites at which sampling and analyses were conducted during RI activities. Figures of each of the sites are presented in Section 2.0.

1.3.1 Old Landfill (LF01)

The Old Landfill is the location of the landfill that received all wastes generated by the station, other than those that were incinerated, from 1956 to approximately 1978. The site was cleaned, covered, and reseeded between 1978 and 1980. It is located approximately a quarter of a mile west of the main installation. The site is less than one acre in size and is bordered on the west by a lagoon, to the south by tundra, and to the north by beach sand and gravels.

1.3.2 Dump Site (LF02)

This site is west of the main station and east of the Old Landfill (LF01) and Dock Storage Area (ST03). The three sites are all located west of the main installation and consist of gravel covered areas; the boundaries between the sites are not readily discernable. The Dump Site was active from the late 1970s to the 1980s. It is reported to have been cleaned up in 1987 (Dames and Moore 1987). Large debris was hauled to the new landfill because the Dump Site was being eroded by the Beaufort Sea.

1.3.3 Dock Storage Area (ST03)

The Dock Storage Area is located west of the POL tanks, east of the Old Landfill (LF01), and west of the Dump Site (LF02). The site is approximately a half acre in size and consists of a gravel

covered area. Drums were reportedly removed from the site prior to 1987. The site was used for storage of drummed liquids prior to 1987.

1.3.4 POL Storage (ST04)

The POL Storage is a gravel pad area located northeast of the hangar and south of the installation airstrip. The gravel pad is approximately 200 feet by 100 feet and adjoins the gravel road leading to the hangar. The storage pad has been identified by previous IRP contractors as Site 19. Currently, a weather monitoring station is constructed on the site. Drummed POL products were reportedly stored at the site until 1987.

1.3.5 Diesel Spill (SS05)

The Diesel Spill area is on the east side of the hangar and has been referred to in previous IRP documents as Site 20. It is the site of an approximately 300-gallon diesel fuel spill that occurred in 1978. The source of the spill was probably the overfilling of the diesel day tank located near the east wall of the hangar. The east side of the hangar area consists of gravel pad that slopes to the east to tundra.

1.3.6 Gasoline Storage Area (ST08)

The Gasoline Storage Area consists of a gravel pad area located to the north and east of the Garage (SS10). Two steel diesel storage tanks were formerly located north of the Garage on the west side of the gravel pad. Presently there is a gasoline storage tank on the gravel pad northeast of the Garage. The site is bordered on the north an east by tundra vegetation and ponds.

1.3.7 Garage (SS10)

The Garage is located approximately 200 feet east of the module train. The Garage is an approximately 90-foot and 40-foot building elevated about four feet above the tundra and is surrounded by gravel on the north, east, and south. The Garage is used for vehicle maintenance and storage. The drains in this building previously discharged directly to the tundra. The drains were sealed by the Air Force in July 1993 to prevent release of contaminants from the garage to the tundra.

1.3.8 Old Sewage Area Petroleum Spill (SS11)

This site consists of tundra and gravel pad areas located approximately 200 feet north and northeast of the module train. The sewage area is located north of the module train at the terminus of an old sewage outfall pipe. To the west of the outfall pipe are tundra and gravel pad areas where a petroleum spill is suspected. This area is just south of the installation's diesel tanks.

Table 1-1 contains a summary of the environmental media sampled at each of these sites. The analytical data obtained from these samples form the basis of the human health and ecological

risk assessments presented in this document. Figures of each of the sites are presented in Section 2.0.

1.4 APPROACH TO HUMAN HEALTH RISK ASSESSMENT

The Oliktok Point DEW Line installation presents a unique challenge in the development of a human health risk assessment. Many of the conventional assumptions applied in risk assessments do not apply to the North Slope of Alaska. Oliktok Point is remote and the area is sparsely populated. Native residents of the North Slope, largely Inupiats, follow a lifestyle that includes a significant subsistence component; much of their food consists of mammals (whales, seals, moose, and caribou), aquatic life (arctic char), and birds (ptarmigan and ducks) that are abundant in this area of the Arctic. The climate is generally harsh, and the soil and surface water are frozen for approximately nine months of the year.

The general approach to the human health risk assessment is to quantify the excess lifetime cancer risk or the noncancer hazard for the site contaminants detected at each of the eight sites at the installation. The maximum concentration of each chemical detected is used instead of an arithmetic mean or 95th percentile upper confidence limit (UCL) because contamination was detected infrequently and generally found to be of low concentration. Incorporating nondetects into the calculation of an average or UCL when the frequency of positive detects is low tends to yield low and unreliable estimates of contamination. Use of the maximum concentration yields a conservative estimate of risk or hazard.

To the extent possible, site-specific information is incorporated into the development of the exposure assumptions. The harsh climate naturally serves to limit exposure to contaminated soil, sediment, and surface water.

Residential exposure assumptions were used to reflect the upper-bound potential future risk. Several North Slope communities have requested use of inactive buildings at DEW Line installations; therefore, an evaluation using potential residential scenarios at the installations and sites was conducted.

Excess lifetime cancer risk and noncancer hazard are calculated for the soil/sediment and water ingestion pathways. Other pathways were eliminated from consideration as described in Section 2.2, Human Health Risk Exposure Assessment.

1.5 APPROACH TO ECOLOGICAL RISK ASSESSMENT

The objective of the ERA is to estimate potential impacts to aquatic and terrestrial plants and animals at the Oliktok Point radar installation. MITRE (1990) suggests that ERAs should "estimate the potential for occurrence of adverse effects that are manifested as changes in the diversity, health and behavior" of ecosystems. MITRE proposes that this can be accomplished by:

- Estimating the health risk to individual species;

- Evaluating the health of the community of exposed species; and

- Determining the potential adverse effects of contamination over several life cycles of the species under study.

Because this is a screening level assessment, the scope of the ERA is limited to the first task: estimating the health risk to individual species. If a potential health risk to individual species was identified, further work may be recommended to evaluate the community and life cycle effects. It is important to note that the health risk to an individual species is different from the health risk to an individual within a species. The former refers to population level biology, where the individual is not considered a relevant endpoint. The latter assesses the risks to an individual. In this ecological assessment, the individual is considered only in the case of threatened or endangered species.

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2.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

The purpose of the baseline human health risk assessment for the Oliktok Point DEW Line installation is to provide a basis for developing a risk management plan, including remedial action alternatives based on data from the RI/FS. The risk assessment develops numerical estimates of cancer risk and noncancer hazard for each site where sufficient information is available. Where information is not adequate to quantify noncancer hazard or cancer risk for a given chemical of concern (COC), a qualitative discussion of the toxicity of that COC is provided in the Toxicity Profiles (Appendix B).

This baseline human health risk assessment addresses issues unique to this location as described in the introduction. It is comprised of six sections:

- Identification of COCs - in which the chemicals detected in environmental samples are compared to risk-based screening levels (RBSLs) and concentrations considered to be applicable or relevant and appropriate requirements (ARAR);

- Exposure assessment - in which the frequency, duration, and magnitude of potential exposures to the COCs are estimated;

- Toxicity assessment - in which the toxicology of the COCs is assessed;

- Risk characterization - in which the potential for adverse health effects in humans as a result of exposure to the COCs is quantified (as appropriate) or qualitatively discussed;

- Uncertainty assessment - in which the general sources of uncertainty in the risk assessment process and the site-specific sources of uncertainty are discussed; and

- Risk assessment summary and conclusions - in which the human health risks are summarized for each site and conclusions based on these risks are presented.

2.1 IDENTIFICATION OF CHEMICALS OF CONCERN

Chemicals of potential concern to human health were evaluated for each site at the Oliktok Point installation based on comparison of chemical concentrations to naturally-occurring background concentrations, RBSLs, ARARs, and safe levels of essential human nutrients (e.g., calcium, magnesium, sodium, and potassium).

This section discusses the RI sampling strategy and an evaluation of data prior to screening (Section 2.1.1), describes and presents equations for calculating RBSLs (Section 2.1.2), identifies chemicals that are essential human nutrients (Section 2.1.3), describes the collection of background samples (Section 2.1.4), and discusses the selection of COCs (Section 2.1.5).

2.1.1 Evaluation of Analytical Data

The RI sampling strategy at the Oliktok Point sites was to characterize the nature and extent of potential contamination at each site. Suspected source areas were sampled to determine the concentrations of contaminants, if any, at the areas likely to have the highest concentrations. Migration pathways from the source areas were sampled to determine the extent, if any, that the contaminants had migrated from the sites. If no discernable pathways were evident, an attempt was made to sample around the source areas to determine the extent of site contaminants. Quick turn-around analyses were conducted on samples from the first sampling event, and a second round of sampling was conducted at those sites where further characterization of the nature and extent of contamination was needed.

Sample types included surface and subsurface soil/sediment samples and surface water samples. In almost all cases, samples were discrete grab samples from one sample location. Surface soil and sediment samples were collected in gravel and tundra areas at or near the ground surface (from ground surface to approximately six inches in depth). Subsurface soil samples were mainly collected in gravel pad areas where unsaturated conditions allowed vertical migration of contaminants. Sediment samples were collected below shallow ponds or streams, or in areas that visually appeared to have been previously covered with water. Surface water samples were collected from ponds, streams, springs, or leachate areas. Surface water samples underwent both total and dissolved metal analyses; however, the total metal analytical results were used in the risk assessment. A summary of the 1993 RI sampling and analyses conducted at the installation is presented in Appendix G.

Before screening for COCs, the results of the RI sampling program were sorted by medium (i.e., soil, sediment, and surface water) and reviewed for quality. The review included an evaluation of the analytical methods used, sample quantitation limits, and qualified data, and a comparison to background levels and laboratory and field blanks. Analytical data were reviewed for completeness, comparability, representativeness, precision, and accuracy. In addition, data validation qualifiers were considered in assessing the quality of the data. The review and validation of analytical data determined that a minimal amount of data was not usable. These data were qualified with an "R" and were not used in the risk assessment.

As outlined in the Risk Assessment Guidance for Superfund (EPA 1989a), site data were compared to available blank (laboratory, field, and trip) data. The data from blanks are presented in Appendix G. In accordance with EPA (1989a), if the detected concentration in a sample was less than 10 times the concentration from blanks for common laboratory contaminants (e.g., acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters) the chemical was not selected for evaluation in the risk assessment. For those organic or inorganic chemicals that are not considered by the U.S. Environmental Protection Agency (EPA) to be common laboratory contaminants (all other compounds), if the detected concentration was less then five times the maximum concentration detected in the blanks, the chemical was not selected for evaluation in the risk assessment.

2.1.2 Risk-Based Screening Levels

An RBSL is a chemical concentration in a particular medium that yields a given cancer risk or hazard quotient (e.g., 10^{-7} cancer risk; or 0.1 hazard quotient) under a given set of conditions. For Oliktok Point, the RBSLs were calculated for soil based on EPA default reasonable maximum exposure (RME) parameters (EPA 1991a). In developing the RBSLs, the most recent toxicity factors available from the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST) were used. IRIS and HEAST are databases of toxicity information for human health risk assessment maintained by the Environmental Criteria and Assessment Office (ECAO) of the EPA. The information presented on IRIS represents the consensus of EPA scientists regarding the toxicity of chemicals released to the environment.

2.1.2.1 Formulae for Calculating RBSLs. The RBSL concentrations were derived using equations in EPA Region 10 guidance (EPA 1991a). The equations are also presented in a slightly different form in the Risk Assessment Guidance for Superfund Volume I, Part B (EPA 1991b). Exposure assessment and risk characterization algorithms for human health risk assessments use site-specific contaminant concentration data, factors describing exposure, and toxicity dose-response values [e.g., reference doses (RfDs) or carcinogen slope factors (SFs)]. These risk assessment algorithms are solved for the concentration term to derive the RBSL for soil and surface water. The algorithms are summarized as follows:

$$\text{Risk} = C \times \left(\frac{CR \times EFD}{BW \times AT}\right) \times SF \quad \text{or} \quad HQ = C \times \left(\frac{CR \times EFD}{BW \times AT}\right) / RfD \qquad \textbf{EQUATION 1, 2}$$

Risk = Target Cancer Risk
C = Concentration
CR = Contact Rate
EFD = Exposure Frequency and Duration
BW = Body Weight
AT = Averaging Time
SF = Slope Factor
HQ = Target Hazard Quotient
RfD = Reference Dose.

RBSLs are calculated based on a specific target cancer risk or hazard quotient (HQ). EPA (1991a) recommends that a 1 x 10^{-7} target cancer risk and a target noncancer HQ of 0.1 be used for soil and a 1 x 10^{-6} risk and 0.1 HQ be used for surface water. The lower target cancer risk is used for screening soil because additional pathways, such as dermal contact and inhalation, are not accounted for by the calculations (EPA 1991a).

Equations (1) and (2) shown above are rearranged to solve for the concentration term (i.e., the RBSL):

$$C = \text{Risk} / \left(\left(\frac{CR \times EFD}{BW \times AT}\right) \times SF\right) \quad \text{or} \quad C = HQ / \left(\left(\frac{CR \times EFD}{BW \times AT}\right) / RfD\right) \qquad \textbf{EQUATION 3, 4}$$

Surface Water Ingestion Equations. Using standard default exposure factors (EPA 1989c) for water ingestion, the equation for cancer risk from drinking water ingestion becomes:

$$\text{Risk} = C\ (\mu g/L) \times 0.001\ mg/\mu g \times \left(\frac{2\ L/day \times 350\ day/year \times 30\ year}{70\ kg \times 70\ year \times 365\ day/year} \right) \times SF_o \qquad \textbf{EQUATION 5}$$

Equation 5 can be rearranged to solve for an RBSL with, for example, a target cancer risk of 10^{-6}:

$$C\ (\mu g/L) = 10^{-6} \times 1{,}000\ \mu g/mg \Big/ \left[\left(\frac{2\ L/day \times 350\ day/year \times 30\ year}{70\ kg \times 70\ year\ 365\ day/year} \right) \times SF_o \right] \qquad \textbf{EQUATION 6}$$

For non-carcinogens, the equation for the HQ for drinking water ingestion is:

$$HQ = C\ (\mu g/L) \times 0.001\ mg/\mu g \times \left(\frac{2\ L/day \times 350\ day/year \times 30\ year}{70\ kg \times 30\ year \times 365\ day/year} \right) / RfD_o \qquad \textbf{EQUATION 7}$$

Equation 7 can be rearranged to provide an equation for the concentration that represents an HQ of 0.1 from ingestion:

$$C\ (\mu g/L) = 0.1 \times 1{,}000\ \mu g/mg \Big/ \left[\left(\frac{2\ L/day \times 350\ day/year \times 30\ year}{70\ kg \times 30\ year \times 365\ day/year} \right) / RfD_o \right] \qquad \textbf{EQUATION 8}$$

Soil or Sediment Ingestion Equations. The equation for calculating carcinogenic risk from soil or sediment ingestion, combining child (subscript c) and adult (subscript a) exposure, is as follows:

$$\text{Risk} = C\ (mg/kg) \times 0.000001\ kg/mg \times \qquad \textbf{EQUATION 9}$$

$$\left[\left(\left(\frac{200_c\ mg/day \times 350_c\ day/year \times 6\ year}{15_c\ kg \times 365\ day/year} \right) + \left(\frac{100_a\ mg/day \times 350_a\ day/year \times 24\ year}{70_a\ kg \times 365\ day/year} \right) \right) / 70\ year \right] \times SF_o$$

Equation 9 can be rearranged to solve for the concentration that represents a target cancer risk of 10^{-7}:

$$C\ (mg/kg) = 10^{-7} \times 1{,}000{,}000\ mg/kg/ \qquad \textbf{EQUATION 10}$$

$$\left[\left(\left(\frac{200_c\ mg/day \times 350_c\ day/year \times 6\ year}{15_c\ kg \times 365\ day/year} \right) + \left(\frac{100_a\ mg/day \times 350_a\ day/year \times 24\ year}{70_a\ kg \times 365\ day/year} \right) \right) / 70\ year \right] \times SF_o$$

For non-carcinogens in soil, Equation 11 is used to calculate the HQ:

HQ = C (mg/kg) x 0.000001 kg/mg x **EQUATION 11**

$$\left[\left(\frac{200_c \text{ mg/day} \times 350_c \text{ day/year} \times 6 \text{ year}}{15_c \text{ kg} \times 365 \text{ day/year}}\right) + \left(\frac{100_a \text{ mg/day} \times 350_a \text{ day/year} \times 24 \text{ year}}{70_a \text{ kg} \times 365 \text{ day/year}}\right) / 30 \text{ year}\right] / RfD_o$$

Equation 11 can be rearranged to solve for the concentration that represents an HQ of 0.1:

C (mg/kg) = 0.1 x 1,000,000 mg/kg / **EQUATION 12**

$$\left[\left(\left(\left(\frac{200_c \text{ mg/day} \times 350_x \text{ day/year} \times 6 \text{ year}}{15_c \text{ kg} \times 365 \text{ day/year}}\right) + \left(\frac{100_a \text{ mg/day} \times 350_a \text{ day/year} \times 24 \text{ year}}{70_a \text{ kg} \times 365 \text{ day/year}}\right)\right) / 30 \text{ year}\right) / RfD_o\right]$$

2.1.3 Screening of Chemicals by Comparing Maximum Detected Concentrations of Essential Human Nutrients

Based on EPA's guidance (1991a), calcium, magnesium, potassium, iron, and sodium are considered to be essential human nutrients and were eliminated from the human health risk assessment at the screening stage. These chemicals are often detected but are not toxic in humans except at extremely high doses. No quantitative toxicity information is available for these elements from EPA sources; therefore, these metals are not selected as COCs for this risk assessment.

2.1.4 Concentrations of Organic and Inorganic Constituents in Background Samples

Four soil, one sediment, and two surface water samples were collected in an area of the radar installation assumed to be unaffected by installation operations. These samples served to determine the concentrations of naturally occurring organic and inorganic constituents in soil, sediment, and surface water (Figure 2-1). Although some naturally occurring compounds were detected in some of the soil, sediment, and surface water background samples in the diesel range petroleum hydrocarbons (DRPH) analyses, the laboratory reported that the chromatograph patterns for these samples were not consistent with patterns for a middle distillate fuel; and the organic concentration in background samples is assumed to be non-detect. This conservative approach was used because it is not possible to determine to what degree, if any, the DRPH detected in site samples were naturally occurring compounds.

In order to obtain a representative range of background inorganic (metal) concentrations in soil, sediments, and surface waters of the North Slope, 44 samples (29 soil/sediment, and 15 water) from seven North Slope radar installations were collected. In addition to Oliktok Point, the installations included Barter Island, Bullen Point, Point Lonely, Point Barrow, Wainwright, and Point Lay. Approximately four soil/sediment and two surface water background samples were collected and analyzed for metals at each of the seven radar installations. Soil and sediment background samples were collected from a depth of zero to six inches.

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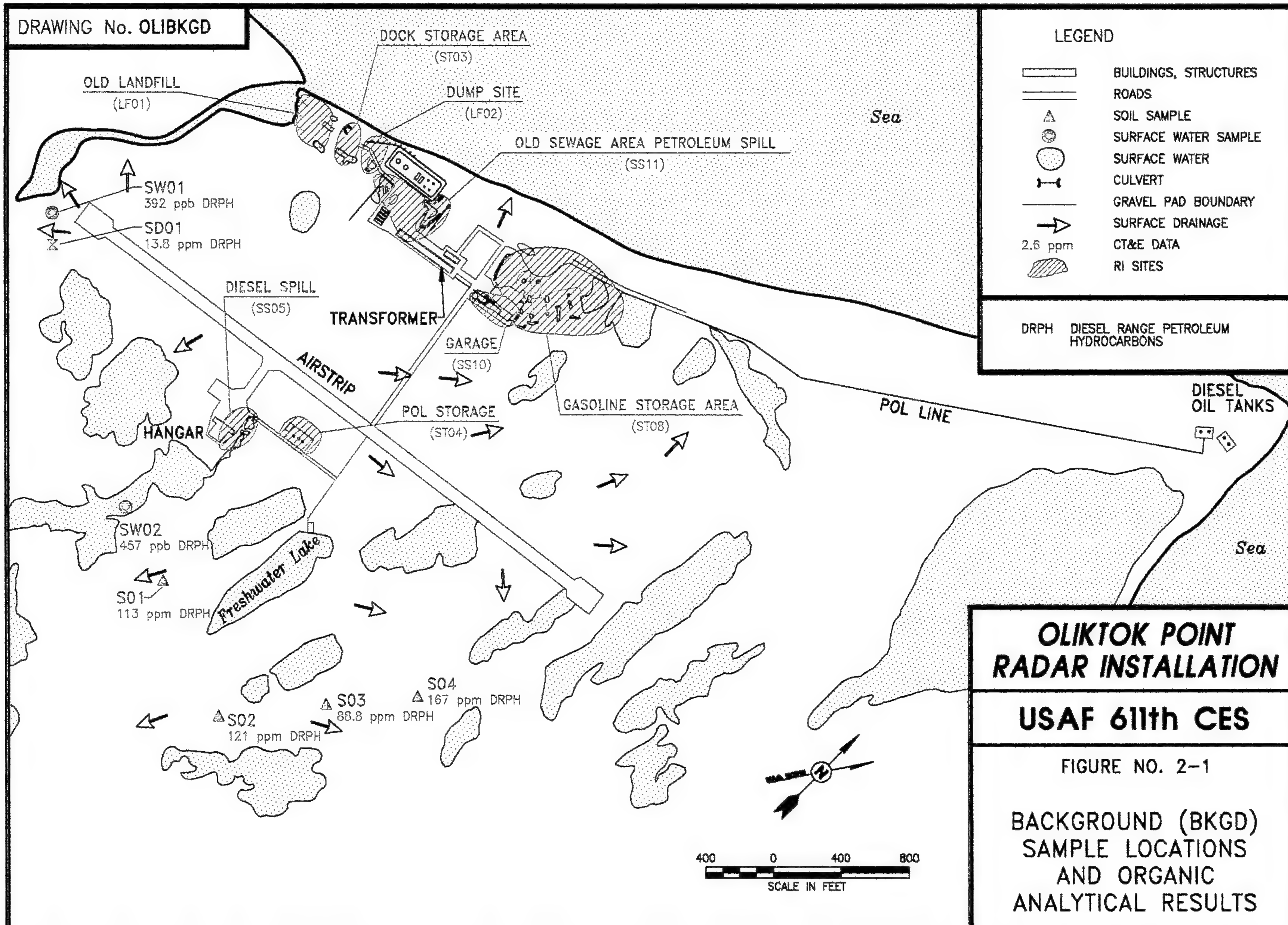

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FIGURE NO. 2-1

BACKGROUND (BKGD) SAMPLE LOCATIONS AND ORGANIC ANALYTICAL RESULTS

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2.1.5 Selection of Chemicals of Concern

Soil and Sediment. The maximum concentrations of the chemicals detected in soil or sediment samples at the Oliktok Point installation and not considered to be essential human nutrients were compared, on a site-by-site basis, to the corresponding background concentrations, RBSLs, and where available, federal or state ARARs. Chemicals detected without an RBSL or ARAR were retained as COCs if concentrations exceeded background levels. A chemical with an RBSL or ARAR was selected as a COC for soil and sediment if the maximum concentration at which the chemical was detected exceeded the corresponding background concentration and the RBSL (based either on cancer risk or noncancer hazard) or ARAR (Table 2-1). Thus, for example, the maximum concentration of GRPH at the Diesel Spill site (SS05), 422 mg/kg, exceeds the background concentration range and the state ARAR of 100 mg/kg. Therefore, GRPH were selected as a COC for the soil at this site.

The COCs for soil/sediment at each site were compared to background concentrations, RBSLs, and ARARs in Table 2-1. The chemicals retained as COCs exceed background concentrations, and the RBSL or an ARAR. A chemical was not retained if the level detected was less than the corresponding RBSL and ARAR, even though background levels were exceeded. The COCs selected that exceed background levels, but do not have an RBSL or an ARAR are discussed below. The COCs selected at each site that exceed an RBSL, ARAR, or both, are discussed in Sections 2.1.5.1 to 2.1.5.8.

Surface Water. The maximum concentrations of the chemicals detected in surface water samples at Oliktok Point were compared, on a site-by-site basis, to the corresponding background concentrations, RBSLs, and where available, federal or state ARARs. Chemicals detected without an RBSL or ARAR were retained as COCs if concentrations exceeded background levels. A chemical with an RBSL or ARAR was selected as a COC for surface water if the maximum concentration at which the chemical was detected exceeded the corresponding background concentration, and the RBSL (based either on cancer risk or noncancer hazard) or ARAR (Table 2-1). Thus, for example, the maximum concentration of GRPH at the Old Landfill (LF01), 70 μg/L, exceeds the background concentration of <2 μg/L (not detected) and the RBSL based on cancer risk of 50 μg/L. Therefore, GRPH were selected as a COC for the surface water at the Old Landfill (LF01) site.

The COCs for surface water at each site were compared to background concentrations, RBSLs, and ARARs in Table 2-1. The chemicals retained as COCs exceed background concentrations and the RBSL or an ARAR. A chemical was not retained if the level detected was less than the corresponding RBSL and ARAR, even though background levels were exceeded. The COCs selected that exceed background levels, but do not have an RBSL or ARAR are discussed below. The COCs at each site that exceed an RBSL, ARAR, or both, are discussed in Sections 2.1.5.1 to 2.1.5.8.

Risk Characterization of Chemicals without RBSLs and ARARs. Several chemicals detected above background levels could not be thoroughly screened because an RBSL could not be calculated and no ARAR was available (Table 2-1). The cancer risk and noncancer hazard for

TABLE 2-1. IDENTIFICATION OF CHEMICALS OF CONCERN: COMPARISON OF MAXIMUM CONCENTRATIONS TO RISK-BASED SCREENING LEVELS, ARARS, AND BACKGROUND EVALUATION OF CHEMICALS DETECTED AT OLIKTOK POINT

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a] CANCER	RBSL[a] NON-CANCER	ARAR[b]	CHEMICAL OF CONCERN
Old Landfill (LF01)	Soil	GRPH	5J	mg/kg	<0.6-<1.00	--	--	100[c]	No
		Toluene	0.1	mg/kg	<0.030-<0.060	--	5,400	--	No
		Ethylbenzene	0.1	mg/kg	<0.030-<0.060	--	2,700	--	No
		Xylenes (total)	0.06J	mg/kg	<0.030-<0.120	--	54,000	--	No
		Tetrachloroethene	0.04	mg/kg	<0.03-<0.045	1.23	270	--	No
		Trichloroethene	0.4J	mg/kg	<0.03-<0.045	5.8	--	--	No
		Aroclor 1254	8.1J	mg/kg	<0.030-<0.100	0.0083	0.54	10[d]	**Yes**
		Aluminum	2,100	mg/kg	1,500-25,000	--	--	--	No
		Barium	130	mg/kg	27-390	--	1,890	--	No
		Calcium	4,800J	mg/kg	350-59,000	--	--	--	No
		Chromium	16	mg/kg	<4.3-47	--	135	--	No
		Copper	8.6	mg/kg	<2.7-45	--	--	--	No
		Iron	7,600	mg/kg	5,400-35,000	--	--	--	No
		Lead	69	mg/kg	<5.1-22	--	--	500[e]	No
		Magnesium	1,100	mg/kg	360-7,400	--	--	--	No
		Manganese	160	mg/kg	25-290	--	3,780	--	No
		Nickel	14	mg/kg	4.2-46	--	540	--	No
		Potassium	340	mg/kg	<300-2,200	--	--	--	No
		Sodium	1,000	mg/kg	<160-680	--	--	--	No
		Vanadium	7.5	mg/kg	6.3-59	--	189	--	No
		Zinc	30	mg/kg	9.2-95	--	8,100	--	No
	Surface Water[k]	GRPH	70J	μg/L	<20	50	730	--	**Yes**
		Toluene	24	μg/L	<1	--	96.5	1,000[f]	No
		Ethylbenzene	3	μg/L	<1	--	158	700[f]	No

TABLE 2-1. IDENTIFICATION OF CHEMICALS OF CONCERN: COMPARISON OF MAXIMUM CONCENTRATIONS TO RISK-BASED SCREENING LEVELS, ARARS, AND BACKGROUND EVALUATION OF CHEMICALS DETECTED AT OLIKTOK POINT (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a] CANCER	RBSL[a] NON-CANCER	ARAR[b]	CHEMICAL OF CONCERN
Old Landfill	Surface Water[k]	Xylenes (total)	31J	µg/L	<2	--	7,300	10,000[f]	No
(LF01)	(Continued)	Aluminum	300	µg/L	<100-350	--	--	--	No
(Continued)		Barium	170	µg/L	<50-93	--	256	2,000[g]	No
		Calcium	85,000J	µg/L	4,500-88,000	--	--	--	No
		Iron	2,300	µg/L	180-2,800	--	--	--	No
		Magnesium	59,000	µg/L	<5,000-53,000	--	--	--	No
		Manganese	360	µg/L	<50-510	--	18.3	--	No
		Potassium	13,000	µg/L	<5,000	--	--	--	No
		Sodium	490,000	µg/L	8,400-410,000	--	--	--	No
Dump Site	Soil	Toluene	0.096	mg/kg	<0.030-<0.045	--	5,400	--	No
(LF02)		Aluminum	7,300J	mg/kg	1,500-25,000	--	--	--	No
		Barium	260	mg/kg	27-390	--	1,890	--	No
		Calcium	11,000	mg/kg	360-59,000	--	--	--	No
		Chromium	12J	mg/kg	<4.3-47	--	135	--	No
		Copper	16	mg/kg	<2.7-45	--	--	--	No
		Iron	17,000	mg/kg	5,400-35,000	--	--	--	No
		Lead	20	mg/kg	<5.1-22	--	--	500[e]	No
		Magnesium	3,300	mg/kg	360-7,400	--	--	--	No
		Manganese	410	mg/kg	25-290	--	3,780	--	No
		Nickel	16	mg/kg	4.2-46	--	540	--	No
		Potassium	980	mg/kg	<300-2,200	--	--	--	No
		Sodium	980	mg/kg	<160-680	--	--	--	No
		Vanadium	20	mg/kg	6.3-59	--	189	--	No

TABLE 2-1. IDENTIFICATION OF CHEMICALS OF CONCERN: COMPARISON OF MAXIMUM CONCENTRATIONS TO RISK-BASED SCREENING LEVELS, ARARS, AND BACKGROUND EVALUATION OF CHEMICALS DETECTED AT OLIKTOK POINT (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a] CANCER	RBSL[a] NON-CANCER	ARAR[b]	CHEMICAL OF CONCERN
Dump Site (LF02) (Continued)	Soil (Continued)	Zinc	84	mg/kg	9.2-95	--	8,100	--	No
	Surface Water[k]	Aluminum	180	µg/L	<100-350	--	--	--	No
		Barium	200	µg/L	<50-93	--	256	2,000[g]	No
		Calcium	67,000J	µg/L	4,500-88,000	--	--	--	No
		Iron	920	µg/L	180-2,800	--	--	--	No
		Magnesium	26,000	µg/L	<5,000-53,000	--	--	--	No
		Manganese	62	µg/L	<50-510	--	18.3	--	No
		Potassium	5,100	µg/L	<5,000	--	--	--	No
		Sodium	95,000	µg/L	8,400-410,000	--	--	--	No
Dock Storage Area (ST03)	Soil	DRPH	300	mg/kg	13.8J-167J	--	--	500[c]	No
		Ethylbenzene	0.02	mg/kg	<0.030-<0.060	--	2,700	--	No
		Xylenes (Total)	0.08J	mg/kg	<0.060-<0.120	--	54,000	--	No
		Aroclor 1254	0.3J	mg/kg	<0.030-<0.100	0.0083	0.54	10[d]	**Yes**
	Surface Water[k]	DRPH	806	µg/L	392-457J	--	292		**Yes**
		1,2-Dichloroethane	1.9	µg/L	<1	0.934	--	5[h]	**Yes**
		Aluminum	270	µg/L	<100-350	--	--	--	No
		Barium	250	µg/L	<50-93	--	256	2,000[g]	No
		Calcium	100,000	µg/L	4,500-88,000	--	--	--	No
		Iron	1,000	µg/L	180-2,800	--	--	--	No
		Magnesium	85,000	µg/L	<5,000-53,000	--	--	--	No
		Manganese	130	µg/L	<50-510	--	18.3	--	No
		Potassium	20,000	µg/L	<5,000	--	--	--	No
		Sodium	59[illegible]00	µg/L	8,400-410,000	--	--	--	No

TABLE 2-1. IDENTIFICATION OF CHEMICALS OF CONCERN: COMPARISON OF MAXIMUM CONCENTRATIONS TO RISK-BASED SCREENING LEVELS, ARARS, AND BACKGROUND EVALUATION OF CHEMICALS DETECTED AT OLIKTOK POINT (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a] CANCER	RBSL[a] NON-CANCER	ARAR[b]	CHEMICAL OF CONCERN
POL Storage	Soil	GRPH	1.03	mg/kg	<0.600-<1.00	--	--	100[c]	No
(ST04)		Toluene	0.054	mg/kg	<0.030-<0.060	--	5,400	--	No
		Xylenes (Total)	0.097	mg/kg	<0.060-<0.120	--	54,000	--	No
Diesel Spill	Soil	DRPH	17,300	mg/kg	13.8J-167J	--	--	500[c]	**Yes**
(SS05)		GRPH	422	mg/kg	<0.600-<1.00	--	--	100[c]	**Yes**
		Toluene	0.29	mg/kg	<0.030-<0.060	--	5,400	--	No
		Ethylbenzene	2.35	mg/kg	<0.030-<0.060	--	2,700	--	No
		Xylenes (Total)	9.90	mg/kg	<0.060-<0.120	--	54,000	--	No
		n-Butylbenzene	0.079	mg/kg	<0.030-<0.045	--	--	--	**Yes***
		p-Isopropyltoluene	0.057	mg/kg	<0.030-<0.045	--	--	--	**Yes***
		Naphthalene	0.501	mg/kg	<0.030-<0.045	--	1,100	--	No
		1,2,4-Trimethylbenzene	0.486	mg/kg	<0.030-<0.045	--	--	--	**Yes***
		1,3,5-Trimethylbenzene	0.232	mg/kg	<0.030-<0.045	--	--	--	**Yes***
	Surface Water	DRPH	425	µg/L	392-457J	--	292	--	**Yes**
Gasoline Storage Area	Soil	DRPH	300,000J	mg/kg	13.8J-167J	--	--	500[c]	**Yes**
(ST08)		GRPH	2,200J	mg/kg	<0.600-<1.00	--	--	100[c]	**Yes**
		RRPH	15,000	mg/kg	NA	--	--	2,000[c]	**Yes**
		Benzene	12.9J	mg/kg	<0.030-<0.060	2.2	--	0.5[c]	**Yes**
		Toluene	15.8	mg/kg	<0.030-<0.060	--	5,400	--	No
		Ethylbenzene	34	mg/kg	<0.030-<0.060	--	2,700	--	No
		Xylenes (Total)	37J	mg/kg	<0.060-<0.120	--	54,000	--	No
		sec-Butylbenzene	0.346	mg/kg	<0.030-<0.045	--	--	--	**Yes***
		Isopropylbenzene	0.525	mg/kg	<0.030-<0.045	--	--	--	**Yes***

TABLE 2-1. IDENTIFICATION OF CHEMICALS OF CONCERN: COMPARISON OF MAXIMUM CONCENTRATIONS TO RISK-BASED SCREENING LEVELS, ARARS, AND BACKGROUND EVALUATION OF CHEMICALS DETECTED AT OLIKTOK POINT (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN
						CANCER	NON-CANCER		
Gasoline Storage Area	Soil	p-Isopropyltoluene	0.273	mg/kg	<0.030-<0.045	--	--	--	**Yes***
(ST08)	(Continued)	Naphthalene	1.99	mg/kg	<0.030-<0.045	--	1,100	--	No
(Continued)		1,2,4-Trimethylbenzene	27.4	mg/kg	<0.030-<0.045	--	--	--	**Yes***
		1,3,5-Trimethylbenzene	24.7	mg/kg	<0.030-<0.045	--	--	--	**Yes***
		Aluminum	3,600	mg/kg	1,500-25,000	--	--	--	No
		Barium	220	mg/kg	27-390	--	1,890	--	No
		Calcium	17,000	mg/kg	360-59,000	--	--	--	No
		Chromium	8.3J	mg/kg	<4.3-47	--	135	--	No
		Copper	17	mg/kg	<2.7-45	--	999	--	No
		Iron	20,000	mg/kg	5,400-35,000	--	--	--	No
		Lead	26	mg/kg	<5.1-22	--	--	500[e]	No
		Magnesium	2,100	mg/kg	360-7,400	--	--	--	No
		Manganese	1,000	mg/kg	25-290	--	3,780	--	No
		Nickel	11	mg/kg	4.2-46	--	540	--	No
		Sodium	540	mg/kg	<160-680	--	--	--	No
		Vanadium	11	mg/kg	6.3-59	--	189	--	No
		Zinc	36	mg/kg	9.2-95	--	8,100	--	No
	Surface Water[k]	1,2-Dichloroethane	1	µg/L	<1	0.934	--	5[h]	**Yes**
		bis (2-Ethylhexyl) phthalate	48	µg/L	<10	6.07	73.0	6[i]	**Yes**
		Barium	220	µg/L	<50-93	--	256	2,000[g]	No
		Calcium	82,000	µg/L	4,500-88,000	--	--	--	No
		Iron	3,100	µg/L	180-2,800	--	--	--	No
		Magnesium	29,[illegible]00	µg/L	<5,000-53,000	--	--	--	No

TABLE 2-1. IDENTIFICATION OF CHEMICALS OF CONCERN: COMPARISON OF MAXIMUM CONCENTRATIONS TO RISK-BASED SCREENING LEVELS, ARARS, AND BACKGROUND EVALUATION OF CHEMICALS DETECTED AT OLIKTOK POINT (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN
						CANCER	NON-CANCER		
Gasoline Storage Area	Surface Water[k]	Manganese	290	µg/L	<50-510	--	18.3	--	No
(ST08) (Continued)	(Continued)	Sodium	120,000	µg/L	8,400-410,000	--	--	--	No
Garage (SS10)	Soil/Sediment	DRPH	75,000J	mg/kg	13.8J-167J	--	--	500[c]	**Yes**
		GRPH	1,500J	mg/kg	<0.600-<1.00	--	--	100[c]	**Yes**
		RRPH	52,000	mg/kg	NA	--	--	2,000[c]	**Yes**
		Benzene	3.5J	mg/kg	<0.030-<0.060	2.2	--	0.5[c]	**Yes**
		Toluene	4.5	mg/kg	<0.030-<0.060	--	5,400	--	No
		Ethylbenzene	9.5	mg/kg	<0.030-<0.060	--	2,700	--	No
		Xylenes (Total)	31J	mg/kg	<0.060-<0.120	--	54,000	--	No
		Tetrachloroethene	5.2J	mg/kg	NA	1.23	270	--	**Yes**
		Fluoranthene	6.77	mg/kg	<0.330-<3.30	--	1,080	--	No
		Pyrene	5.32	mg/kg	<0.330-<3.30	--	810	--	No
		bis (2-Ethylhexyl) phthalate	5.53	mg/kg	<0.330-<3.30	4.57	540	--	**Yes**
		Aroclor 1254	3J	mg/kg	<0.030-<0.100	0.0083	0.54	10[d]	**Yes**
		Aluminum	2,100	mg/kg	1,500-25,000	--	--	--	No
		Barium	130	mg/kg	27-390	--	1,890	--	No
		Calcium	5,600	mg/kg	360-59,000	--	--	--	No
		Chromium	7.6J	mg/kg	<4.3-47	--	135	--	No
		Copper	18	mg/kg	<2.7-45	--	999	--	No
		Iron	7,300	mg/kg	5,400-35,000	--	--	--	No
		Lead	48	mg/kg	<5.1-22	--	--	500[e]	No
		Magnesium	1,100	mg/kg	360-7,400	--	--	--	No
		Manganese	94	mg/kg	25-290	--	3,780	--	No

TABLE 2-1. IDENTIFICATION OF CHEMICALS OF CONCERN: COMPARISON OF MAXIMUM CONCENTRATIONS TO RISK-BASED SCREENING LEVELS, ARARS, AND BACKGROUND EVALUATION OF CHEMICALS DETECTED AT OLIKTOK POINT (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a] CANCER	RBSL[a] NON-CANCER	ARAR[b]	CHEMICAL OF CONCERN
Garage (SS10)	Soil/Sediment	Nickel	8.1	mg/kg	4.2-46	--	540	--	No
(Continued)	(Continued)	Potassium	370	mg/kg	<300-2,200	--	--	--	No
		Sodium	200	mg/kg	<160-<680	--	--	--	No
		Vanadium	8.5	mg/kg	6.3-59	--	189	--	No
		Zinc	130	mg/kg	9.2-95	--	8,100	--	No
	Surface Water[k]	Barium	290	µg/L	<50-93	--	256	2,000[g]	**Yes**
		Calcium	77,000	µg/L	4,500-88,000	--	--	--	No
		Iron	2,200	µg/L	180-2,800	--	--	--	No
		Magnesium	29,000	µg/L	<5,000-53,000	--	--	--	No
		Manganese	120	µg/L	<50-510	--	18.3	--	No
		Sodium	100,000	µg/L	8,400-410,000	--	--	--	No
Old Sewage Area	Soil/Sediment	DRPH	4,700J	mg/kg	13.8J-167J	--	--	500[c]	**Yes**
Petroleum Spill (SS11)		GRPH	389	mg/kg	<0.600-<1.00	--	--	100[c]	**Yes**
		Benzene	0.038	mg/kg	<0.030-<0.060	2.2	--	0.5[c]	No
		Toluene	1.99	mg/kg	<0.030-<0.045	--	5,400	--	No
		Ethylbenzene	2.85	mg/kg	<0.030-<0.060	--	2,700	--	No
		Xylenes (Total)	18.65	mg/kg	<0.060-<0.120	--	54,000	--	No
		n-Butylbenzene	8.07	mg/kg	<0.030-<0.045	--	--	--	**Yes***
		sec-Butylbenzene	3.49	mg/kg	<0.030-<0.045	--	--	--	**Yes***
		Isopropylbenzene	2.42	mg/kg	<0.030-<0.045	--	--	--	**Yes***
		p-Isopropylbenzene	3.59	mg/kg	<0.030-<0.045	--	--	--	**Yes***
		Naphthalene	9.30	mg/kg	<0.030-<0.045	--	1,100	--	No
		n-Propylbenzene	5.49	mg/kg	<0.030-<0.045	--	--	--	**Yes***

TABLE 2-1. IDENTIFICATION OF CHEMICALS OF CONCERN: COMPARISON OF MAXIMUM CONCENTRATIONS TO RISK-BASED SCREENING LEVELS, ARARS, AND BACKGROUND EVALUATION OF CHEMICALS DETECTED AT OLIKTOK POINT (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN
						CANCER	NON-CANCER		
Old Sewage Area	Soil/Sediment	1,2,4-Trimethylbenzene	21.3	mg/kg	<0.030-<0.045	--	--	--	Yes*
Petroleum Spill (SS11)	(Continued)	1,3,5-Trimethylbenzene	9.84	mg/kg	<0.030-<0.045	--	--	--	Yes*
(Continued)		Benzyl Alcohol	2.50	mg/kg	<0.330-<3.30	--	8,100	--	No
		di-n-Butylphthalate	0.582	mg/kg	<0.330-<3.30	--	2,700	--	No
		bis (2-Ethylhexyl) phthalate	0.701	mg/kg	<0.330-<3.30	4.57	540	--	No
		2-Methylnaphthalene	2.23	mg/kg	<0.330-<3.30	--	--	--	Yes*
		Aroclor 1254	0.045	mg/kg	<0.030-<0.100	0.00831	0.54	10[d]	Yes
		Aluminum	2,600	mg/kg	1,500-25,000	--	--	--	No
		Barium	170	mg/kg	27-390	--	1,890	--	No
		Calcium	9,000	mg/kg	360-59,000	--	--	--	No
		Chromium	6.0	mg/kg	<4.3-47	--	135	--	No
		Copper	16	mg/kg	<2.7-45	--	999	--	No
		Iron	9,500	mg/kg	5,400-35,000	--	--	--	No
		Lead	18	mg/kg	<5.1-22	--	--	500[e]	No
		Magnesium	1,800	mg/kg	360-7,400	--	--	--	No
		Manganese	150	mg/kg	25-290	--	3,780	--	No
		Nickel	8.5	mg/kg	4.2-46	--	540	--	No
		Potassium	450	mg/kg	<300-2,200	--	--	--	No
		Sodium	240	mg/kg	<160-680	--	--	--	No
		Vanadium	9.5	mg/kg	6.3-59	--	189	--	No
		Zinc	110	mg/kg	9.2-95	--	8,100	--	No
	Surface Water	DRPH	1,110J	µg/L	392-457J	--	292	--	Yes
		GRPH	142	µg/L	<20	50	730	--	Yes

TABLE 2-1. IDENTIFICATION OF CHEMICALS OF CONCERN: COMPARISON OF MAXIMUM CONCENTRATIONS TO RISK-BASED SCREENING LEVELS, ARARS, AND BACKGROUND EVALUATION OF CHEMICALS DETECTED AT OLIKTOK POINT (CONTINUED)

SITE	MATRIX	CHEMICAL DETECTED	MAXIMUM CONCENTRATION	UNITS	BACKGROUND RANGE	RBSL[a]		ARAR[b]	CHEMICAL OF CONCERN
						CANCER	NON-CANCER		
Old Sewage Area	Surface Water[k]	Toluene	5.7	µg/L	<1	--	96.5	1,000[f]	No
Petroleum Spill (SS11)	(Continued)	Xylenes (Total)	8.5	µg/L	<2	--	7,300	10,000[f]	No
(Continued)		1,4-Dichlorobenzene	1.1	µg/L	<1	3.5	--	--	No
		1,2-Dichloroethane	3.3J	µg/L	<1	0.934	--	5[h]	**Yes**
		p-Isopropyltoluene	5.3	µg/L	<1	--	--	--	**Yes***
		Naphthalene	10	µg/L	<1	--	150	--	No
		1,2,4-Trimethylbenzene	31	µg/L	<1	--	--	--	**Yes***
		1,3,5-Trimethylbenzene	13	µg/L	<1	--	--	--	**Yes***
		Aluminum	17,000	µg/L	<100-350	--	--	--	No
		Barium	750	µg/L	<50-93	--	256	2,000[g]	**Yes**
		Calcium	140,000	µg/L	4,500-88,000	--	--	--	No
		Copper	570	µg/L	<50	--	135	1,300[i]	**Yes**
		Iron	64,000	µg/L	108-2,800	--	--	--	No
		Lead	110	µg/L	<100	--	--	15[j]	**Yes**
		Magnesium	32,000	µg/L	<5,000-53,000	--	--	--	No
		Manganese	2,500	µg/L	<50-510	--	18.3	--	**Yes**
		Potassium	15,000	µg/L	<5,000	--	--	--	No
		Sodium	110,000	µg/L	8,400-410,000	--	--	--	No
		Vanadium	66	µg/L	<50	--	25.6	--	**Yes**
		Zinc	840	µg/L	<50-160	--	1,100	--	No

* Chemicals without an RBSL or ARAR are considered chemicals of potential concern and are discussed in Section 2.1.5.
NA Not analyzed.
a Risk-Based Screening Level.
b ...licable or Relevant and Appropriate Requirement.

TABLE 2-1. IDENTIFICATION OF CHEMICALS OF CONCERN: COMPARISON OF MAXIMUM CONCENTRATIONS TO RISK-BASED SCREENING LEVELS, ARARS, AND BACKGROUND EVALUATION OF CHEMICALS DETECTED AT OLIKTOK POINT (CONTINUED)

c ADEC 1991.
d TSCA cleanup level.
e EPA 1991c.
f MCL, 56 FR 3526 (30 January 1991).
g MCL, 56 FR 30266 (01 January 1991).
h MCL, 52 FR 25690 (08 July 1987).
i MCL, 57 FR 31776 (17 July 1992).
j MCL, 56 FR 26460 (07 June 1991).
k The concentrations reported for metals in surface water are total metals.
B The analyte was detected in the associated blank.
J Result is an estimate.
N The analysis indicates the presence of analyte for which there is presumptive evidence to make a "tentative identification".

these chemicals cannot, therefore, be quantified. A list of these chemicals is presented in Table 2-2.

This section is a qualitative discussion of the potential for these chemicals to cause toxicity among the receptor groups identified at the Oliktok Point installation. The essential human nutrients were discussed in Section 2.1.3 and will not be discussed further here. Essential nutrients are not considered COCs in this risk assessment.

The American Petroleum Institute (API) recently published an evaluation of the environmental fate, transport, and toxicity of twelve organic chemicals found frequently in petroleum products. The twelve were selected from a large list of "candidates" based on:

- abundance in crude and refined petroleum products, including residual and used oils;

TABLE 2-2. CHEMICALS WITHOUT RBSLS AND ARARS OBSERVED IN THE SOIL, SEDIMENT, OR SURFACE WATER AT THE OLIKTOK POINT INSTALLATION

SUBSTITUTED BENZENES
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
p-Isopropyltoluene
Isopropylbenzene
n-Propylbenzene
sec-Butylbenzene
n-Butylbenzene
p-Isopropylbenzene
ESSENTIAL HUMAN NUTRIENTS
Calcium
Iron
Magnesium
Potassium
Sodium
POLYNUCLEAR AROMATIC HYDROCARBONS
2-Methylnaphthalene

- chemical/physical properties that represent a range of mobilities in soil and solubilities in aqueous environments; and

- toxicity in mammals and aquatic organisms (API 1994).

One of the chemicals detected at the Oliktok Point installation, 1,2,4-trimethylbenzene was selected from the list of twelve chemicals (API 1994) and is used in this risk assessment as a surrogate for the substituted benzenes without RBSLs and ARARs (Table 2-2). In addition, 2-methylnaphthalene does not have an RBSL or ARAR and, therefore, the toxicity of naphthalene will be discussed in order to assess 2-methylnaphthalene.

1,2,4-Trimethylbenzene has a low order of toxicity in mammals (API 1994). No effect was observed on the kidneys of rats that received 0.5 or 2.0 g/kg orally five days per week for four weeks. Inhalation of high concentrations of 1,2,4-trimethylbenzene produces central nervous system depression in humans and rats. Lung toxicity, including bronchitis, pneumonitis, and edema, was also observed in humans. 1,2,4-Trimethylbenzene has not been observed to be carcinogenic or mutagenic in laboratory studies of rats and cultured mammalian cells. Potential exposure of receptors to 1,2,4-trimethylbenzene at the Oliktok Point installation would probably be limited to oral ingestion of soil and at the maximum concentration measured (27.4 mg/kg soil) would be expected to be nontoxic.[1] For the purposes of this risk assessment, 1,2,4-trimethylbenzene is considered to be a reasonable surrogate for the substituted benzenes observed at the Oliktok Point installation.

Because of the lack of toxicology information available for 2-methylnaphthalene, naphthalene will be used as a surrogate. Naphthalene has a low order of toxicity in mammals (API 1994). The toxicology of this chemical has been well characterized in several species, including humans, rats, rabbits, and mice. The toxicity in humans is known from cases of accidental or intentional (suicide) ingestion of contaminated food or mothballs, and the most common effect is liver damage (jaundice) and destruction of red blood cells resulting in anemia. These effects occur at exposure levels that far exceed the levels to which the receptor groups at the Oliktok Point installation could be exposed. Dose-response information is available from studies in rats, mice, and rabbits. High doses of naphthalene administered over several days to one month resulted in cataract formation and other less serious ocular effects. High doses administered over several days to three months produced mild toxic effects on the liver, lung, kidney, and immunological system. The no effect level of oral exposure in these species occurs in the range of 100 to 300 mg naphthalene per kg body weight per day (100 to 300 mg/kg/day). The oral exposure levels to 2-methylnaphthalene that may occur through soil ingestion at the Oliktok Point installation are approximately 0.000006 mg/kg/day. Furthermore, the maximum concentration of

---

[1] Based on the following calculation: assume average daily soil ingestion rate of 200 mg of soil per day and 27.4 mg of 1,2,4-trimethylbenzene per kg of soil (maximum concentration measured at Oliktok Point installation). This yields a dose of 0.000078 mg of 1,2,4-trimethylbenzene per kg body weight per day. The oral dose of 1,2,4-trimethylbenzene received by rats that showed no kidney effects was equivalent to 2,000 mg of 1,2,4-trimethylbenzene per kg body weight, which is more than 25,000,000 times greater than the estimated dose for potential receptors at the Oliktok Point installation.

2-methylnapthalene is less than the RBSL for naphthalene. Therefore, any exposure to 2-methylnaphthalene in the soil at the Oliktok Point installation is expected to be nontoxic.[2]

In conclusion, the chemicals discussed above have been marked in Table 2-1 as potential COCs to indicate that there is some uncertainty in screening out these chemicals. Without toxicity criteria the potential risks of these chemical cannot be quantified. However, based on the information presented above, and the concentrations measured at the sites, these chemicals are not expected to pose a heath risk.

Chemicals with RBSLs and/or ARARs. Following are discussions of the COCs at each site that exceeded background levels and an RBSL, ARAR, or both. The site figures in Sections 2.1.5.1 through 2.1.5.8 present all organic compounds detected at the sites and inorganic analytes that exceeded background levels and an associated RBSL or ARAR. A summary of the COCs selected for the sites at the Oliktok Point installation is presented at the end of this section.

2.1.5.1 Old Landfill (LF01).

Soil or Sediment. Aroclor 1254 was identified as a COC for the soil matrix at the Old Landfill (Table 2-1 and Figure 2-2). The maximum concentration of Aroclor 1254 exceeded the background concentration and the RBSLs based on cancer risk and noncancer hazard.

Surface Water. GRPH was identified as a COC for surface water at the Old Landfill (Figure 2-2). GRPH exceeded the background concentration (<20 μg/L, not detected) and the RBSL based on cancer risk (Table 2-1).

2.1.5.2 Dump Site (LF02).

Soil or Sediment. No COC was identified for the soil matrix at the Dump Site (Figure 2-3) based on a comparison of the maximum concentrations of detected chemicals to their background, RBSL, and ARAR concentrations (Table 2-1).

Surface Water. No COC was identified for the surface water at the Dump Site (Figure 2-3) based on a comparison of the maximum concentrations of detected chemicals to their background, RBSL, and ARAR concentrations (Table 2-1).

2.1.5.3 Dock Storage Area (ST03).

Soil or Sediment. Aroclor 1254 was identified as a COC for the soil matrix at the Dock Storage Area (Figure 2-4). Aroclor 1254 exceeded the background concentration and the RBSL based on cancer risk but did not exceed the RBSL based on noncancer hazard of the ARAR, which is a cleanup level promulgated under the Toxic Substances Control Act (TSCA) (Table 2-1).

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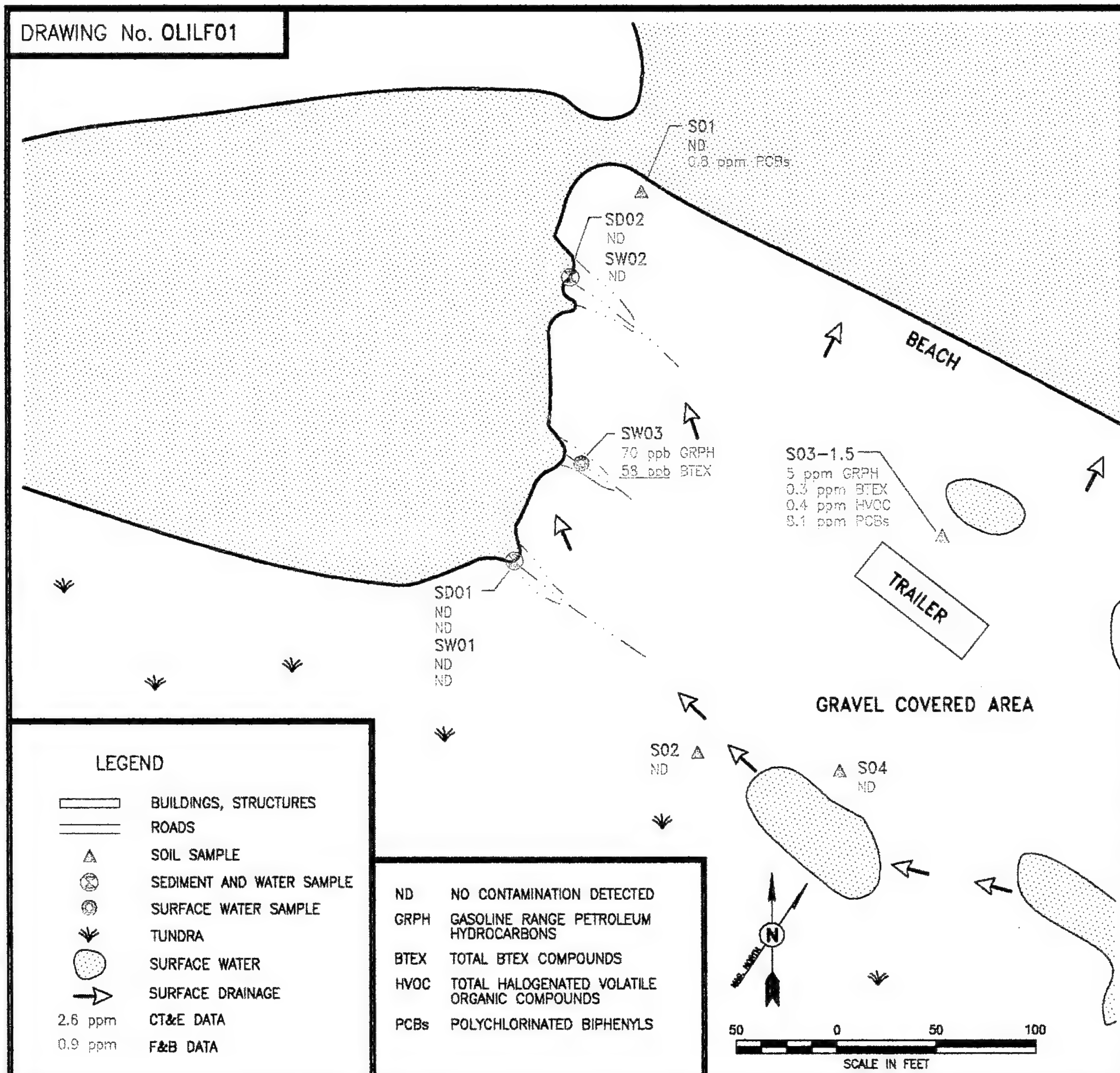
[2] Based on the following assumptions: soil ingestion rate, 200 mg/day; 70 kg body weight for typical receptor; maximum soil concentration of 2-methylnaphthalene, 2.23 mg/kg.



OLIKTOK POINT RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 2-2

OLD LANDFILL (LF01) SAMPLE LOCATIONS AND ANALYTICAL RESULTS

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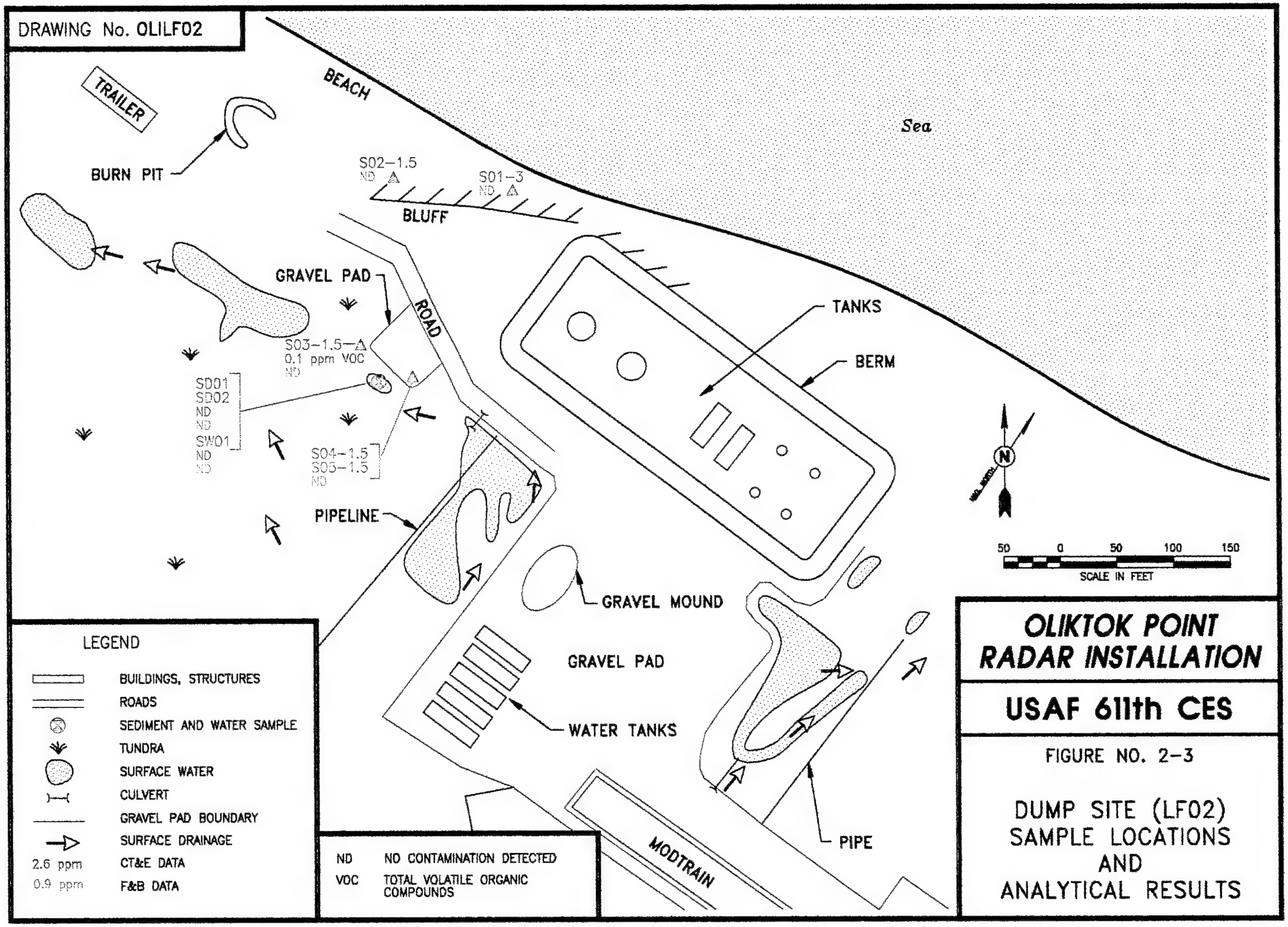
DRAWING No. OLILF02
TRAILER
BURN PIT
BEACH
Sea
S02-1.5
ND
S01-3
ND
BLUFF
GRAVEL PAD
ROAD
S03-1.5
0.1 ppm VOC
ND
SD01
SD02
ND
ND
SW01
ND
ND
S04-1.5
S05-1.5
ND
PIPELINE
TANKS
BERM
GRAVEL MOUND
GRAVEL PAD
WATER TANKS
MODTRAIN
PIPE
N
50 0 50 100 150
SCALE IN FEET
LEGEND
BUILDINGS, STRUCTURES
ROADS
SEDIMENT AND WATER SAMPLE
TUNDRA
SURFACE WATER
CULVERT
GRAVEL PAD BOUNDARY
SURFACE DRAINAGE
2.6 ppm CT&E DATA
0.9 ppm F&B DATA
ND NO CONTAMINATION DETECTED
VOC TOTAL VOLATILE ORGANIC COMPOUNDS
OLIKTOK POINT RADAR INSTALLATION
USAF 611th CES
FIGURE NO. 2-3
DUMP SITE (LF02) SAMPLE LOCATIONS AND ANALYTICAL RESULTS

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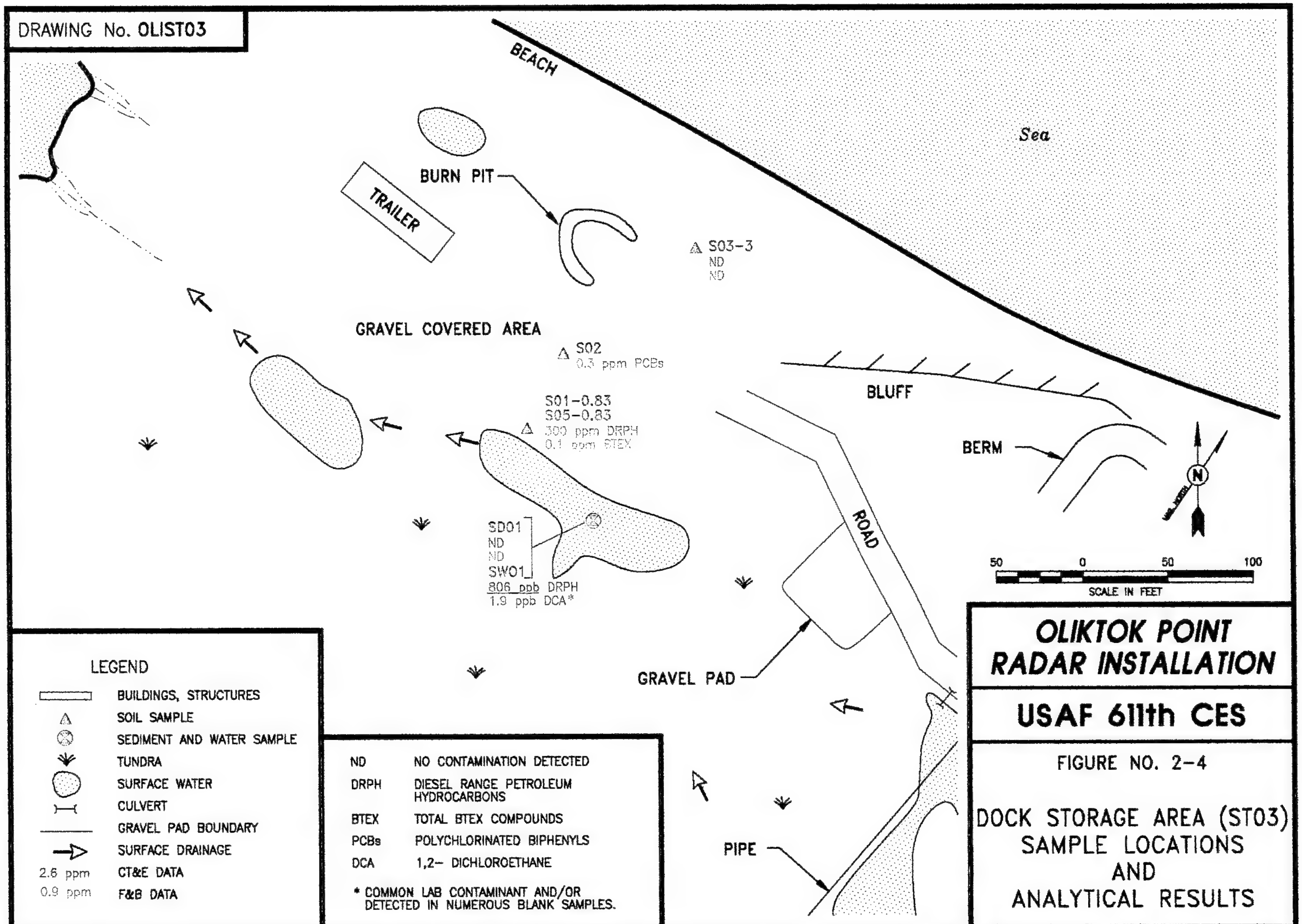
DRAWING No. OLIST03
Sea
BEACH
BURN PIT
TRAILER
S03-3
ND
ND
GRAVEL COVERED AREA
S02
0.3 ppm PCBs
S01-0.83
S05-0.83
300 ppm DRPH
0.1 ppm BTEX
SD01
ND
ND
SW01
806 ppb DRPH
1.9 ppb DCA*
BLUFF
BERM
ROAD
GRAVEL PAD
PIPE
50 0 50 100
SCALE IN FEET
LEGEND
BUILDINGS, STRUCTURES
SOIL SAMPLE
SEDIMENT AND WATER SAMPLE
TUNDRA
SURFACE WATER
CULVERT
GRAVEL PAD BOUNDARY
SURFACE DRAINAGE
2.6 ppm CT&E DATA
0.9 ppm F&B DATA
ND NO CONTAMINATION DETECTED
DRPH DIESEL RANGE PETROLEUM HYDROCARBONS
BTEX TOTAL BTEX COMPOUNDS
PCBs POLYCHLORINATED BIPHENYLS
DCA 1,2- DICHLOROETHANE
* COMMON LAB CONTAMINANT AND/OR DETECTED IN NUMEROUS BLANK SAMPLES.
OLIKTOK POINT
RADAR INSTALLATION
USAF 611th CES
FIGURE NO. 2-4
DOCK STORAGE AREA (ST03)
SAMPLE LOCATIONS
AND
ANALYTICAL RESULTS

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Surface Water. DRPH and 1,2-dichloroethane were identified as COCs for the surface water at the Dock Storage Area (Figure 2-4). DRPH exceeded the background concentration and the RBSL based on noncancer hazard. 1,2-Dichloroethane exceeded the background concentration (<1 µg/L, not detected) and the RBSL based on cancer risk.

2.1.5.4 POL Storage (ST04).

Soil or Sediment. No COC was identified for the soil matrix at the POL Storage (Figure 2-5) based on a comparison of the maximum concentrations of detected chemicals to their background, RBSL, and ARAR concentrations (Table 2-1).

Surface Water. No surface water bodies were identified at the POL Storage; therefore, no surface water COCs have been identified (Figure 2-5).

2.1.5.5 Diesel Spill (SS05).

Soil or Sediment. DRPH and GRPH were identified as COCs for the soil matrix at the Diesel Spill site (Figure 2-6). The maximum concentrations of DRPH and GRPH exceeded their background concentrations and the ARAR concentrations for petroleum hydrocarbon contamination of soil (ADEC 1991) (Table 2-1).

Surface Water. DRPH was identified as a COC for the surface water at the Diesel Spill site (Figure 2-6) based on a comparison of the maximum concentrations of detected chemicals to their background, RBSL, and ARAR concentrations (Table 2-1). Although DRPH was detected in background, the organic concentration was conservatively assumed to be non-detect because it is not possible to determine to what degree, if any, the DRPH detected at SS05 was naturally occurring.

2.1.5.6 Gasoline Storage Area (ST08).

Soil or Sediment. DRPH, GRPH, RRPH, and benzene were identified as COCs for the soil matrix at the Gasoline Storage Area (Figure 2-7). DRPH and GRPH exceeded their background concentrations and the ARAR concentrations for petroleum hydrocarbon contamination of soil (ADEC 1991) (Table 2-1). A background concentration was not available for evaluation of the maximum concentration of RRPH; however, this mixture exceeded the ARAR concentration for petroleum hydrocarbon contamination of soil (ADEC 1991) (Table 2-1). Benzene exceeded the background concentration, the RBSL based on cancer risk, and the ARAR based on ADEC (1991).

Surface Water. 1,2-Dichloroethane and bis(2-ethylhexyl)phthalate were identified as COCs for the surface water at the Gasoline Storage Area (Figure 2-7). The maximum concentration of 1,2-dichloroethane exceeded the background concentration (<1 µg/L, not detected) and the RBSL based on cancer risk, but did not exceed the ARAR, which is an MCL promulgated under the federal Safe Drinking Water Act (Table 2-1). The maximum concentration of bis(2-ethylhexyl)phthalate exceeded the background concentration (<10 µg/L, not detected), the RBSL based on cancer risk, and the ARAR, which is an MCL promulgated under the federal Safe

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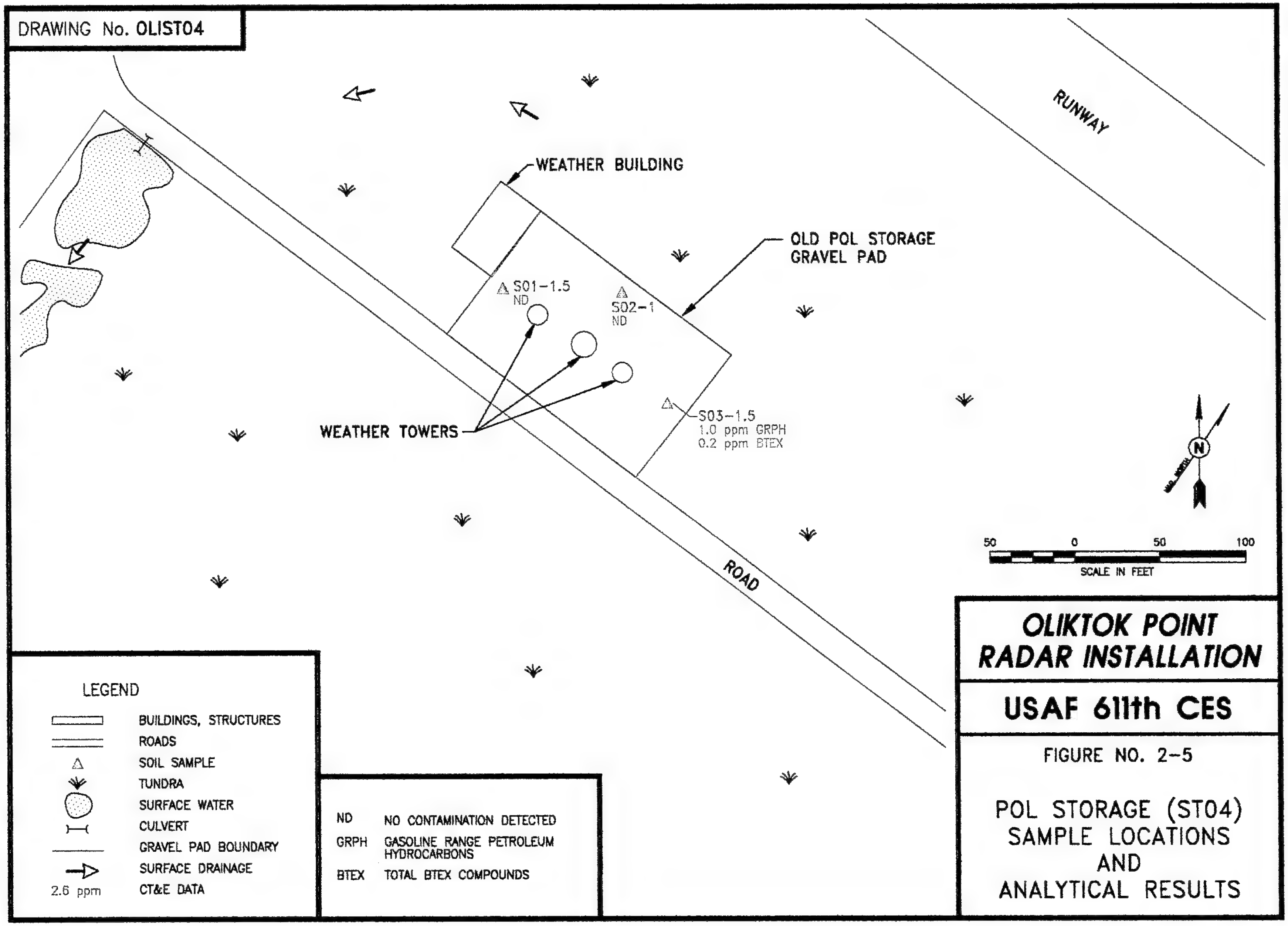

DRAWING No. OLIST04
RUNWAY
WEATHER BUILDING
OLD POL STORAGE
GRAVEL PAD
S01-1.5
ND
S02-1
ND
S03-1.5
1.0 ppm GRPH
0.2 ppm BTEX
WEATHER TOWERS
ROAD
N
50
0
50
100
SCALE IN FEET
LEGEND
BUILDINGS, STRUCTURES
ROADS
SOIL SAMPLE
TUNDRA
SURFACE WATER
CULVERT
GRAVEL PAD BOUNDARY
SURFACE DRAINAGE
2.6 ppm
CT&E DATA
ND NO CONTAMINATION DETECTED
GRPH GASOLINE RANGE PETROLEUM HYDROCARBONS
BTEX TOTAL BTEX COMPOUNDS
OLIKTOK POINT
RADAR INSTALLATION
USAF 611th CES
FIGURE NO. 2-5
POL STORAGE (ST04)
SAMPLE LOCATIONS
AND
ANALYTICAL RESULTS

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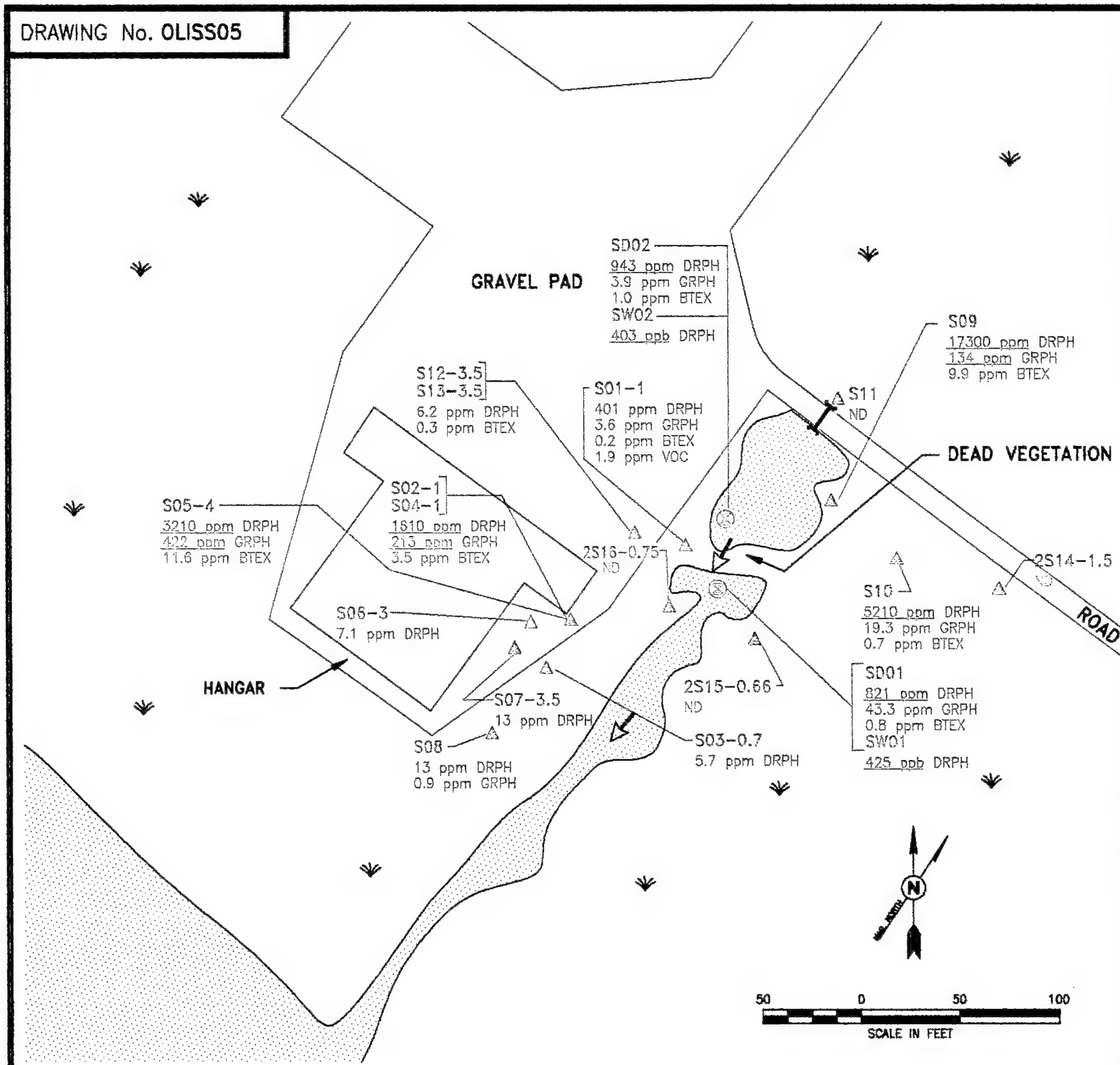
DRAWING No. OLISS05



LEGEND

- BUILDINGS, STRUCTURES
- SOIL SAMPLE
- SEDIMENT SAMPLE
- SURFACE WATER SAMPLE
- SEDIMENT AND WATER SAMPLE
- TUNDRA
- SURFACE WATER
- CULVERT
- GRAVEL PAD BOUNDARY
- SURFACE DRAINAGE
- 2.6 ppm CT&E DATA
- 0.9 ppm F&B DATA

0000	CONCENTRATIONS ARE ABOVE ACTION LEVELS
ND	NO CONTAMINATION DETECTED
VOC	TOTAL VOLATILE ORGANIC COMPOUNDS
DRPH	DIESEL RANGE PETROLEUM HYDROCARBONS
GRPH	GASOLINE RANGE PETROLEUM HYDROCARBONS
BTEX	TOTAL BTEX COMPOUNDS

OLIKTOK POINT RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 2-6

DIESEL SPILL (SS05) SAMPLE LOCATIONS AND ANALYTICAL RESULTS

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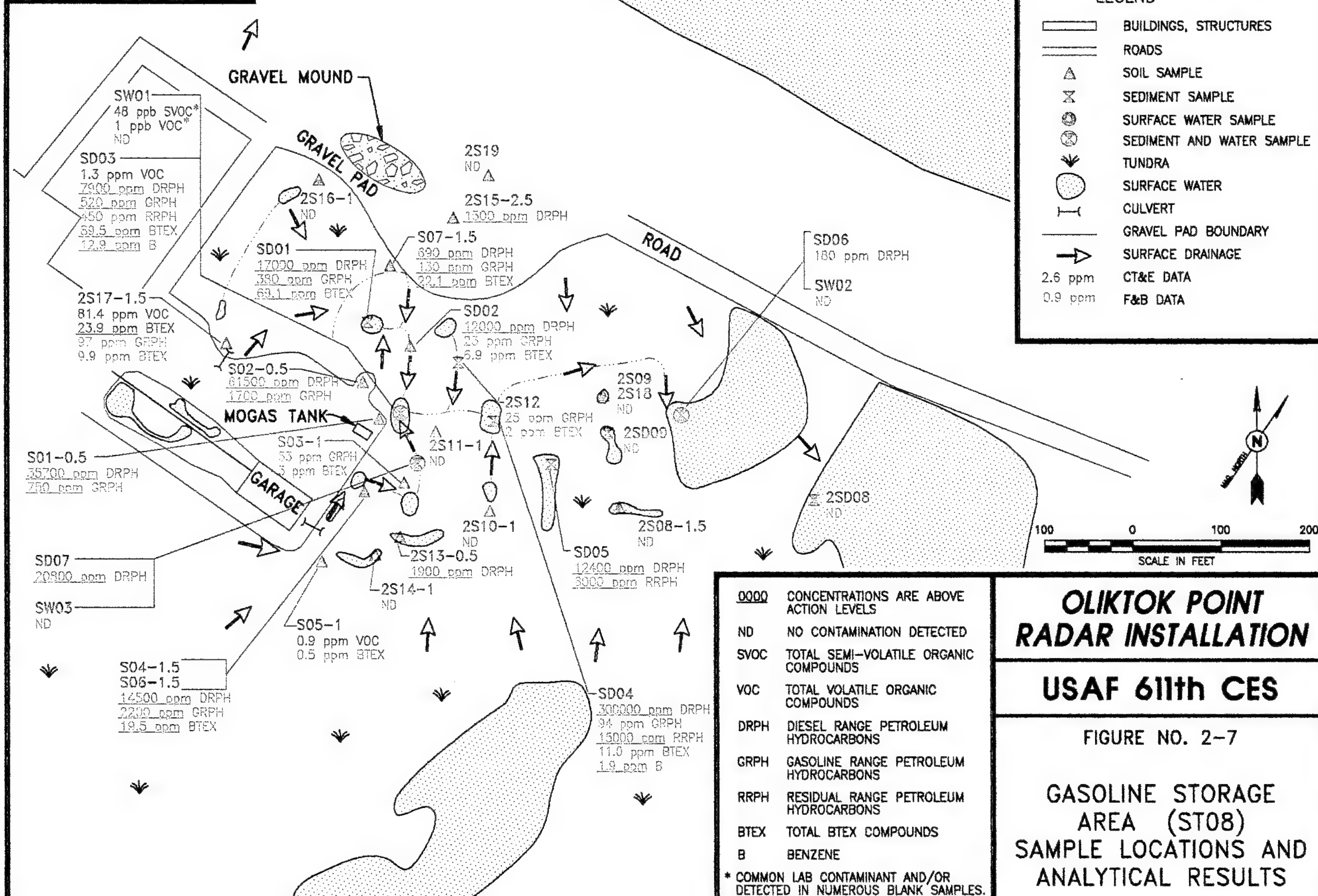
DRAWING No. OLIST08



LEGEND

BUILDINGS, STRUCTURES
ROADS
SOIL SAMPLE
SEDIMENT SAMPLE
SURFACE WATER SAMPLE
SEDIMENT AND WATER SAMPLE
TUNDRA
SURFACE WATER
CULVERT
GRAVEL PAD BOUNDARY
SURFACE DRAINAGE
2.6 ppm CT&E DATA
0.9 ppm F&B DATA

0000	CONCENTRATIONS ARE ABOVE ACTION LEVELS
ND	NO CONTAMINATION DETECTED
SVOC	TOTAL SEMI-VOLATILE ORGANIC COMPOUNDS
VOC	TOTAL VOLATILE ORGANIC COMPOUNDS
DRPH	DIESEL RANGE PETROLEUM HYDROCARBONS
GRPH	GASOLINE RANGE PETROLEUM HYDROCARBONS
RRPH	RESIDUAL RANGE PETROLEUM HYDROCARBONS
BTEX	TOTAL BTEX COMPOUNDS
B	BENZENE

* COMMON LAB CONTAMINANT AND/OR DETECTED IN NUMEROUS BLANK SAMPLES.

OLIKTOK POINT RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 2-7

GASOLINE STORAGE AREA (ST08) SAMPLE LOCATIONS AND ANALYTICAL RESULTS

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Drinking Water Act (Table 2-1). Bis(2-ethylhexyl)phthalate did not exceed the RBSL based on noncancer hazard.

2.1.5.7 Garage (SS10).

Soil or Sediment. DRPH, GRPH, RRPH, benzene, tetrachloroethene, bis(2-ethylhexyl)phthalate, and Aroclor 1254 were identified as COCs for the soil matrix at the Garage (Figure 2-8). The maximum concentrations of DRPH, GRPH, and RRPH exceeded the ARAR concentration for petroleum hydrocarbon contamination of soil (ADEC 1991) (Table 2-1). The maximum concentration of benzene exceeds the background concentration (not detected), the RBSL based on cancer risk, and the ARAR based on ADEC (1991). The maximum concentrations of tetrachloroethene and bis(2-ethylhexyl)phthalate exceeded their RBSLs based on cancer risk but not the RBSLs based on noncancer hazard (Table 2-1). Aroclor 1254 was present at a maximum concentration that exceeded the background concentration and the RBSLs based on cancer risk and noncancer hazard but not the ARAR promulgated under the TSCA (Table 2-1).

Surface Water. Barium was identified as a COC for the surface water at the Garage (Figure 2-8). The maximum concentration of barium exceeded the background concentration range of <50-93 μg/L and the RBSL based on noncancer hazard (Table 2-1). Barium did not exceed the ARAR, which is an MCL promulgated under the Safe Drinking Water Act.

2.1.5.8 Old Sewage Area Petroleum Spill (SS11).

Soil or Sediment. DRPH, GRPH, and Aroclor 1254 were identified as COCs for the soil matrix at the Old Sewage Area Petroleum Spill site (Figure 2-9). The maximum concentrations of DRPH and GRPH exceeded their background concentrations and the ARAR concentrations for petroleum hydrocarbon contamination of soil (ADEC 1991) (Table 2-1). Aroclor 1254 exceeded the RBSL based on cancer risk.

Surface Water. DRPH, GRPH, 1,2-dichloroethane, barium, copper, lead, manganese, and vanadium were identified as COCs for the surface water at the Old Sewage Area Petroleum Spill site (Figure 2-9). The maximum concentrations of DRPH, barium, copper, manganese, and vanadium exceeded their background concentrations and RBSLs based on noncancer hazard. GRPH and 1,2-dichloroethane exceeded their RBSLs based on cancer risk. The maximum concentration of lead exceeded the ARAR, which is an MCL promulgated under the federal Safe Drinking Water Act (see Lead and Copper Rule of the SDWA). Barium and copper did not exceed their ARARs based on MCLs (Table 2-1).

2.1.5.9 Summary of Chemicals of Concern. The assessment of human health risk at the Oliktok Point radar installation will be based on the COCs identified in this section and is summarized in Table 2-3.

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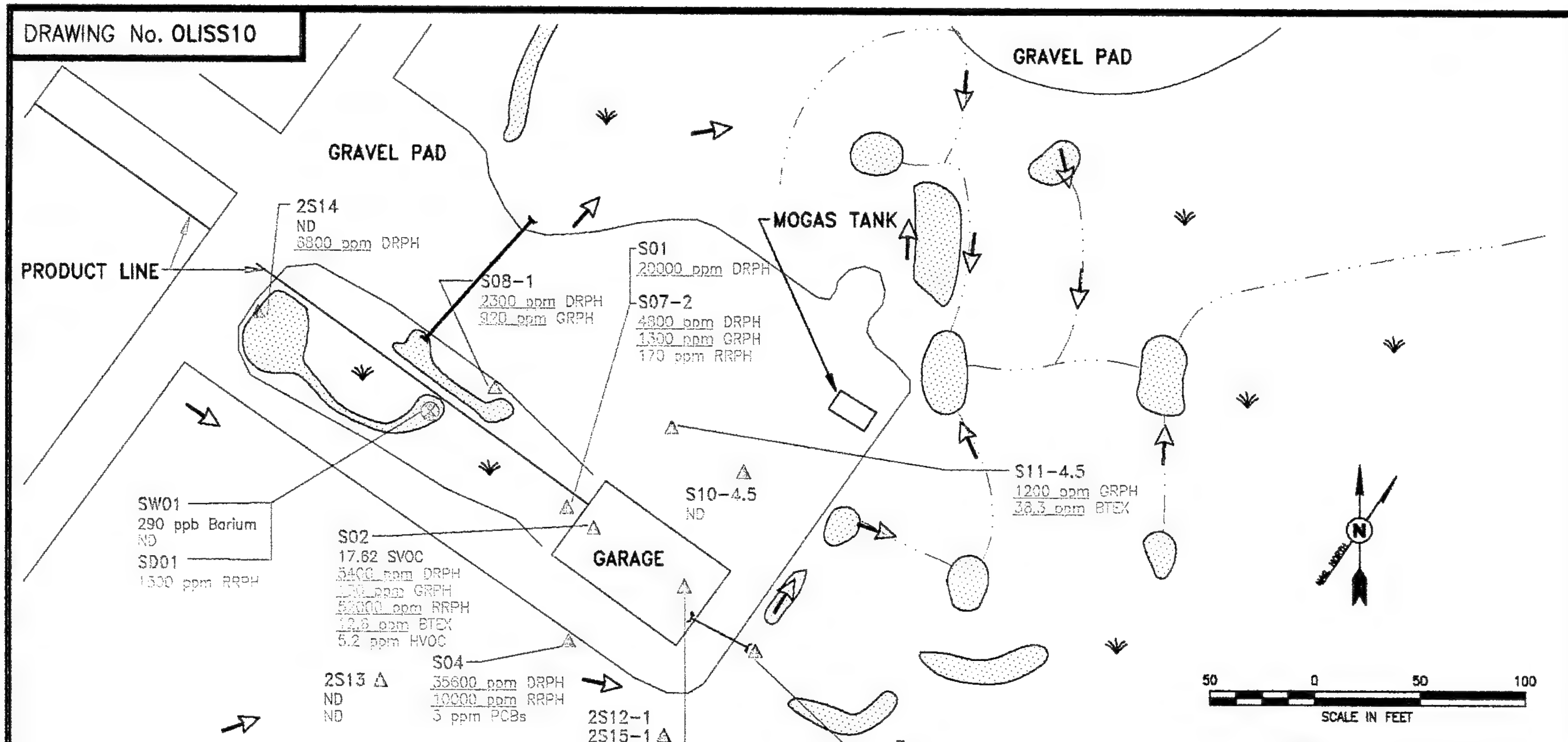
DRAWING No. OLISS10



LEGEND

	BUILDINGS, STRUCTURES
	ROADS
	SOIL SAMPLE
	SEDIMENT AND WATER SAMPLES
	SURFACE WATER
	TUNDRA
	CULVERT
	GRAVEL PAD BOUNDARY
	SURFACE DRAINAGE
2.6 ppm	CT&E DATA
0.9 ppm	F&B DATA

0000	CONCENTRATIONS ARE ABOVE ACTION LEVELS
ND	NO CONTAMINATION DETECTED
SVOC	TOTAL SEMI-VOLATILE ORGANIC COMPOUNDS
DRPH	DIESEL RANGE PETROLEUM HYDROCARBONS
GRPH	GASOLINE RANGE PETROLEUM HYDROCARBONS

RRPH	RESIDUAL RANGE PETROLEUM HYDROCARBONS
BTEX	TOTAL BTEX COMPOUNDS
B	BENZENE
HVOC	TOTAL HALOGENATED VOLATILE ORGANIC COMPOUNDS
PCBs	POLYCHLORINATED BIPHENYLS

OLIKTOK POINT RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 2-8

GARAGE (SS10)
SAMPLE LOCATIONS
AND
ANALYTICAL RESULTS

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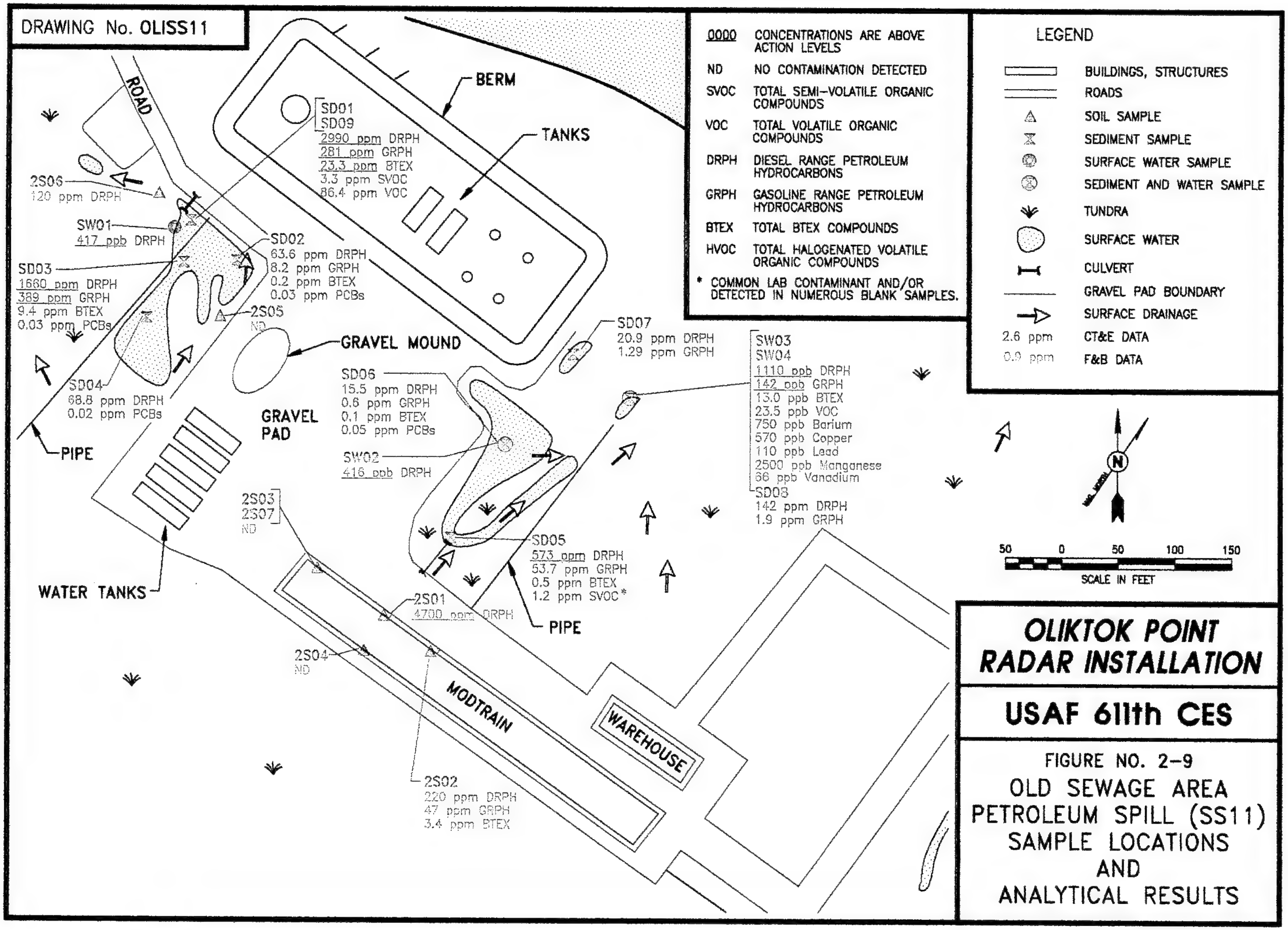
DRAWING No. OLISS11
ROAD
BERM
TANKS
SD01
SD09
2990 ppm DRPH
281 ppm GRPH
23.3 ppm BTEX
3.3 ppm SVOC
86.4 ppm VOC
2S06
120 ppm DRPH
SW01
417 ppb DRPH
SD02
63.6 ppm DRPH
8.2 ppm GRPH
0.2 ppm BTEX
0.03 ppm PCBs
SD03
1660 ppm DRPH
389 ppm GRPH
9.4 ppm BTEX
0.03 ppm PCBs
2S05
ND
GRAVEL MOUND
SD04
68.8 ppm DRPH
0.02 ppm PCBs
PIPE
GRAVEL PAD
SD06
15.5 ppm DRPH
0.6 ppm GRPH
0.1 ppm BTEX
0.05 ppm PCBs
SW02
416 ppb DRPH
SD07
20.9 ppm DRPH
1.29 ppm GRPH
SW03
SW04
1110 ppb DRPH
142 ppb GRPH
13.0 ppb BTEX
23.5 ppb VOC
750 ppb Barium
570 ppb Copper
110 ppb Lead
2500 ppb Manganese
66 ppb Vanadium
SD08
142 ppm DRPH
1.9 ppm GRPH
2S03
2S07
ND
WATER TANKS
SD05
573 ppm DRPH
53.7 ppm GRPH
0.5 ppm BTEX
1.2 ppm SVOC*
2S01
4700 ppm DRPH
PIPE
2S04
ND
MODTRAIN
WAREHOUSE
2S02
220 ppm DRPH
47 ppm GRPH
3.4 ppm BTEX
0000 CONCENTRATIONS ARE ABOVE ACTION LEVELS
ND NO CONTAMINATION DETECTED
SVOC TOTAL SEMI-VOLATILE ORGANIC COMPOUNDS
VOC TOTAL VOLATILE ORGANIC COMPOUNDS
DRPH DIESEL RANGE PETROLEUM HYDROCARBONS
GRPH GASOLINE RANGE PETROLEUM HYDROCARBONS
BTEX TOTAL BTEX COMPOUNDS
HVOC TOTAL HALOGENATED VOLATILE ORGANIC COMPOUNDS
* COMMON LAB CONTAMINANT AND/OR DETECTED IN NUMEROUS BLANK SAMPLES.
LEGEND
BUILDINGS, STRUCTURES
ROADS
SOIL SAMPLE
SEDIMENT SAMPLE
SURFACE WATER SAMPLE
SEDIMENT AND WATER SAMPLE
TUNDRA
SURFACE WATER
CULVERT
GRAVEL PAD BOUNDARY
SURFACE DRAINAGE
2.6 ppm CT&E DATA
0.9 ppm F&B DATA
N
50 0 50 100 150
SCALE IN FEET
OLIKTOK POINT RADAR INSTALLATION
USAF 611th CES
FIGURE NO. 2-9
OLD SEWAGE AREA PETROLEUM SPILL (SS11) SAMPLE LOCATIONS AND ANALYTICAL RESULTS

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TABLE 2-3. SUMMARY OF THE CHEMICALS OF CONCERN AT OLIKTOK POINT

SITE	CHEMICALS OF CONCERN*	
	SOIL/SEDIMENT	SURFACE WATER
Old Landfill (LF01)	Aroclor 1254	GRPH
Dump Site (LF02)	NONE	NONE
Dock Storage Area (ST03)	Aroclor 1254	DRPH 1,2-Dichloroethane
POL Storage (ST04)	NONE	NONE
Diesel Spill (SS05)	DRPH GRPH	DRPH
Gasoline Storage Area (ST08)	DRPH GRPH RRPH Benzene	1,2-Dichloroethane bis(2-Ethylhexyl)phthalate
Garage (SS10)	DRPH GRPH RRPH Benzene Tetrachloroethene bis(2-Ethylhexyl)phthalate Aroclor 1254	Barium
Old Sewage Area Petroleum Spill (SS11)	DRPH GRPH Aroclor 1254	DRPH GRPH 1,2-Dichloroethane Barium Copper Lead Manganese Vanadium

* The summary of COCs on this table includes only those chemicals detected that exceed background levels and an RBSL, ARAR, or both. COCs that exceeded background levels but do not have an RBSL or ARAR are discussed in Section 2.1.5 (Page 2-9).

2.2 EXPOSURE ASSESSMENT

The exposure assessment section of a baseline human health risk assessment identifies and describes potential receptors and the exposure pathways by which exposure may occur, and estimates the magnitude of those exposures. This section includes an analysis of which pathways are complete (Section 2.2.1), migration and fate of COCs (Section 2.2.2), an estimation of the total intake of the chemicals (Section 2.2.3), and a summary of how the average daily dose (ADD) was calculated (Section 2.2.4).

2.2.1 Pathway Analysis

Pathway analysis involves the evaluation of the components of potential exposure pathways and a determination of whether each pathway is complete. An exposure pathway describes the course a chemical will take from a source to an exposure point where a receptor can come into contact with the chemical. A complete exposure pathway has five components:

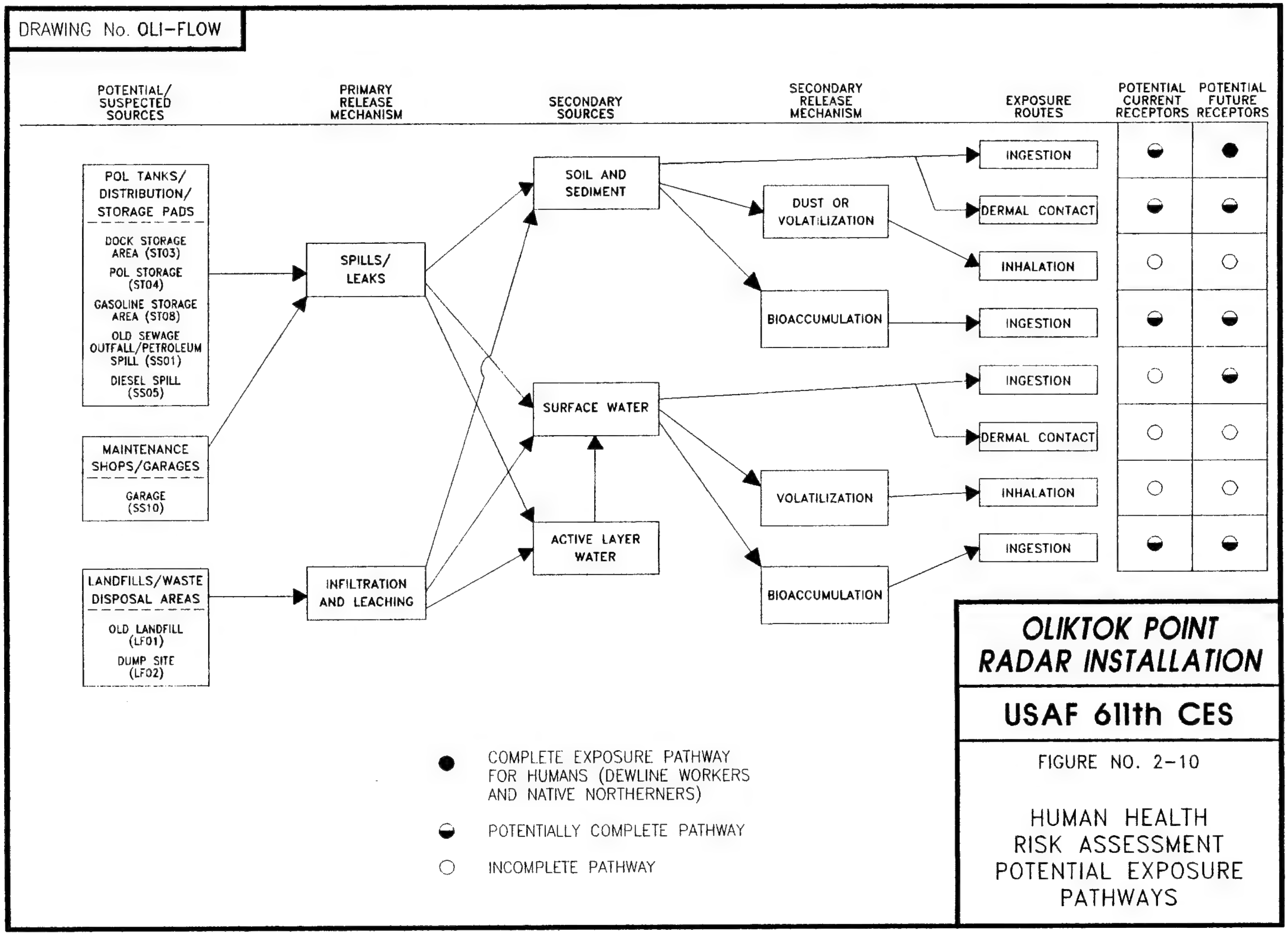
- source of contamination;
- release mechanism;
- transport mechanism;
- exposure point; and
- receptor.

If one component of an exposure pathway does not exist, then exposure will not occur and there is no health risk. For example, if a shallow aquifer was contaminated with tetrachloroethylene, but that aquifer was not used as a water supply, no exposure point would exist, and a ground water ingestion pathway would not be complete.

The potential exposure pathways evaluated for the Oliktok Point human health risk assessment are presented in Figure 2-10 and Table 2-4, and are discussed in Sections 2.2.1.1 through 2.2.1.4.

2.2.1.1 Soil and Sediment Ingestion. Oliktok Point installation workers may be exposed to soil and sediment contaminated by previous operations at the installation. The most likely exposure routes are incidental ingestion of soil and dermal absorption of contaminants in the soil. Site-specific characteristics will limit the magnitude, frequency, and duration of exposures to soil and sediment. The ground is covered with snow and ice, eliminating soil or sediment exposure for approximately nine months of the year. In the summer months when snow cover is generally absent, cool temperatures (30°F to 46°F) (University of Alaska 1978) keep workers in heavy, long-sleeved clothing and gloves that eliminate dermal contact with and hand-to-mouth transfer of soil. Therefore, although both the incidental soil ingestion and dermal contact pathways are unlikely to be complete, incidental ingestion of soil or sediment will be evaluated further in this risk assessment in order to provide a conservative estimate of risk.

The exposure assumptions used to evaluate the soil and sediment ingestion pathway are upper bound residential scenario assumptions and, therefore, probably overestimate the true hazard or risk associated with this pathway. The purpose of using residential assumptions is to evaluate



OLIKTOK POINT RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 2-10

HUMAN HEALTH RISK ASSESSMENT POTENTIAL EXPOSURE PATHWAYS

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TABLE 2-4. EXPOSURE PATHWAY ANALYSIS FOR OLIKTOK POINT HUMAN HEALTH RISK ASSESSMENT

POTENTIALLY CONTAMINATED MEDIUM	POTENTIAL ROUTES OF EXPOSURE	POTENTIAL RECEPTORS	PATHWAY COMPLETE?	EXPOSED POPULATION ESTIMATE
Soil	Ingestion, dermal absorption	DEW Line workers, native villagers	Ingestion, Yes Dermal Contact, No	100[a]
Sediment	Ingestion, dermal absorption	DEW Line workers, native villagers	Ingestion, Yes Dermal Contact, No	100[a]
Air	Inhalation of volatiles from soil or surface water or inhalation of fugitive dust	DEW Line workers, native villagers	No, volatile concentrations in soil and surface water are very low; dust generation is not likely because of marshy vegetated landscape and high humidity; and snow and ice cover most of the year.	0
Surface Water	Incidental ingestion, dermal absorption	DEW Line workers, native villagers	Maybe, drinking water supplies are either upgradient from installation or in unaffected areas. Fishing occurs in unaffected areas. Swimming does not occur onsite; however, incidental exposure may occur during installation operations or trespassing by native villagers.	100[a]
Ground Water	Ingestion, dermal absorption	DEW Line workers, native villagers	No, permafrost limits presence of ground water to shallow active layer that is not used for any purpose.	0

a Exposed population estimate is based on the assumption that, at some time in the future, the installation will be decommissioned and released for residential use.

the hazard or risk associated with future residential use of the Oliktok Point installation. Although the Air Force does not plan to close the Oliktok Point radar installation, it is possible that at some time in the future the installation may be retired and released for civilian use, in which case residential use of the installation may be possible.

2.2.1.2 Inhalation. Oliktok Point installation workers and native northerners may be exposed to site contamination by inhalation of organic compounds that have volatilized from the soil or surface water, or by inhalation of windborne dust to which contamination has adsorbed. These exposure pathways are not considered complete for the Oliktok Point risk assessment because snow and ice cover the site for approximately nine months of the year, and during the summer months the high humidity, vegetative cover, and thawing of surface and active layer water significantly limit the entrainment of dust particles in ambient air. The generally low temperatures and high moisture content of the soil also tend to inhibit volatilization. The inhalation pathway will not be considered further in this risk assessment.

2.2.1.3 Water Ingestion. Surface water features, particularly those potentially contaminated by operations at the installation, are not likely to be used for drinking or other domestic purposes even on an incidental basis. This is because these surface water features are frozen for most of the year; therefore, they are not reliable sources of water for domestic or industrial use. Ingestion of surface water will, however, be considered a potentially complete exposure pathway to reflect an upper bound potential risk under a future use scenario. Under current conditions, surface water at the installation is not used for domestic or other purposes. Water for the installation is obtained from a freshwater lake located upgradient in an area not expected to be impacted by operations at the installation.

2.2.1.4 Ground Water. Permafrost limits the presence of ground water to the active layer, which thaws during the summer months. The water present in the active layer is not known to be used for any purpose; therefore, a ground water pathway will be eliminated from consideration in this risk assessment.

2.2.2 Migration and Fate of Chemicals of Concern

The COCs selected for Oliktok Point generally fall into four classes:

- Refined and residual petroleum hydrocarbons (DRPH, GRPH, and RRPH);
- Volatile organic compounds (VOCs: benzene, bis(2-ethylhexyl)phthalate, 1,2-dichloroethane, and tetrachloroethene);
- Polychlorinated biphenyls (Aroclor 1254); and
- Metals (barium, copper, lead, manganese, and vanadium).

This section presents a summary of the migration and fate of each of these classes given the environmental conditions at Oliktok Point.

Once released to the environment, the COCs are immediately subject to several processes, including evaporation and volatilization, bulk flow, soil adsorption, dissolution in surface or active layer water, biodegradation, and photooxidation. The extent to which the COCs undergo each of these processes depends on their chemical and physical properties (e.g., K_{OC}, K_{OW}, water

solubility, vapor pressure, Henry's law constant), the volume released, soil flora, meteorological conditions, soil moisture, and organic carbon content.

The migration of petroleum hydrocarbons released to the gravel pads and tundra is expected to follow the rank order: GRPH > DRPH > RRPH. GRPH is generally considered to include hydrocarbons with carbon chain ranges from C_5 to C_{12} that tend to be reactively mobile and less persistent than longer chain hydrocarbons. Depending on the length of time since a spill or leak occurred, the petroleum hydrocarbons observed in soil samples would be expected to be enriched in components that have carbon chain ranges greater than C_{10} or C_{11}, have high K_{OC} and K_{OW} values, low vapor pressure and water solubility, and are not rapidly biodegradable. Petroleum components that fit this profile are higher molecular weight n-alkanes, mono- and poly-aromatics, and cycloalkanes. These components would tend to appear in laboratory analyses as diesel range or heavy oil range organics (DRPH and RRPH).

The migration of VOCs is expected to be rapid compared to the petroleum hydrocarbons. VOCs tend to have high vapor pressures which favor volatilization, high water solubility, and low K_{OC} and K_{OW} values. Therefore, VOCs would tend to be highly mobile in the environment and dissipate rapidly after a spill or leak. In the results of field sampling, VOC concentrations would be expected to be fairly low depending on the time since the spill or leak occurred. The frigid conditions on the North Slope, however, would tend to reduce the mobility due to volatilization or evaporation.

PCBs also have a low migratory potential. These compounds are generally of high molecular weight, low vapor pressure and water solubility, and high K_{OC} and K_{OW} values. Biodegradation of PCBs on the North Slope would also be expected to be minimal given the frigid conditions and presence of permafrost.

The metals observed at Oliktok Point are probably of natural origin and not due to the operation of or activities at the radar installation. The presence of barium and manganese in water samples is most often associated with leachate from contaminated areas since the anaerobic and acidic conditions tend to release naturally occurring manganese from the soil. Metals will tend to be persistent and of low mobility in the environment.

In conclusion, the COCs observed at the Oliktok Point installation are generally expected to be fairly persistent and of low mobility. Exposure by contact with soils, primarily through accidental ingestion, is expected to predominate compared to exposure by inhalation.

2.2.3 Estimation of Chemical Intake

The exposure assessment for the Oliktok Point DEW Line installation required the development of site-specific assumptions because of the unique location on the North Slope of Alaska. This section of the report focuses on the exposure variables for which site-specific assumptions were made. These variables include:

- exposure frequency;
- exposure duration;

- ingestion of locally produced meat (e.g., caribou, fish, and birds);
- ingestion of locally produced vegetation (e.g., berries);
- soil ingestion rate; and
- rate of dermal contact with soil.

The exposure assumptions used in the human health risk assessment are presented in Table 2-5.

Three potential receptor groups will be evaluated for the Oliktok Point risk assessments: an adult assigned to maintenance work at the Oliktok Point installation (DEW Line worker), an adult native of the North Slope of Alaska (native), and a native child (child). The native adult and child are considered to represent the reasonable maximum exposure that might occur at the installation under a future use scenario that includes residential receptors. Although there are no plans to do so, the Oliktok Point installation may be released for civilian residential use in the future.

The estimation of chemical intake requires the evaluation of several exposure variables: exposure point concentration; exposure frequency; exposure duration; ingestion of locally produced meat, fish, and vegetation; soil ingestion; drinking water ingestion; dermal contact with soil; inhalation; and body weight. These exposure variables are discussed in the following sections.

TABLE 2-5. EXPOSURE ASSUMPTIONS FOR ESTIMATING CHEMICAL INTAKE

PARAMETER	DEW LINE WORKER	NATIVE NORTHERN ADULT	NATIVE NORTHERN CHILD
Exposure Frequency - Soil Ingestion (days/year)	30	30	30
Exposure Frequency - Water Ingestion (days/year)	180	180	N/A
Exposure Duration (years)	10	55[a]	6[a]
Soil Ingestion Rate (mg/day)	50	100	200
Drinking Water Ingestion Rate (L/day)	2	2	N/A
Average Body Weight (kg)	70	70	15
Averaging Time (days)	25,550[b] (cancer) 3,650[c,d] (noncancer)	25,550[b] (cancer) 20,075[c] (noncancer) 17,885[d] (noncancer)	2,190[d] (noncancer)

N/A Not applicable; drinking water pathway evaluated for adult only.

a Exposure duration for water ingestion pathway is 55 years. For soil ingestion, exposure duration is 6 years as a child and 49 years as an adult.

b Averaging time for the evaluation of cancer risk by the soil and water ingestion pathways.

c Averaging time for the evaluation of noncancer hazard by the water ingestion pathway.

d Averaging time for the evaluation of noncancer hazard by the soil ingestion pathway.

2.2.3.1 Exposure Point Concentration. Based on the amount of analytical data available for the risk assessment of the Oliktok Point installation, and the requirement that the risk characterization be conducted individually for each of the eight sites, only maximum concentrations of the COCs were used for exposure point concentrations. This approach yields a conservative upper-bound estimate of the ADD for potential receptors.

2.2.3.2 Exposure Frequency. The exposure frequency variable is an estimate of the amount of time a potential receptor may contact contaminated media. For the DEW Line worker, the exposure frequency estimate is based on a duty rotation of eleven months onsite, one month offsite. During the eleven months of onsite duty, it is estimated that the worker is outside for four hours per day. The remaining 20 hours is spent inside the module trains or enclosed vehicles, where exposure to contaminated media is not expected to occur. An estimated exposure frequency for the DEW Line worker is, therefore, 11 months/year x 30 days/month x 4 hours/day x 1 day/24 hours = 55 days/year. The primary environmental medium of concern is, however, contaminated soil, and this estimate of exposure frequency does not account for the number of days per year that snow covers the ground and eliminates the potential for contact with contaminated soil. Six months is a conservative average estimate of the number of months per year of snow cover at arctic DEW Line installations. To be even more conservative, it is assumed that a worker's tour of duty includes all six of the months without snow cover, thus an exposure frequency of 30 days/year for the DEW Line worker is recommended.

The soil ingestion exposure frequency estimate for a native adult or child of the North Slope is based on an estimate of the frequency with which the individual would be at a DEW Line installation involved in activities that include exposure to soil. Such visits are not likely to occur at installations located far from native villages. In this case, a conservative estimate of exposure would be 4 hrs/day x 30 days per month x 1 day/24 hrs x 6 months of exposed soil = 30 days per year.

The exposure frequency for surface water ingestion was conservatively estimated at 180 days/year that surface water would be available (i.e., not frozen), and is based on a potential future scenario where site surface water is used as a drinking water source.

2.2.3.3 Exposure Duration. The exposure duration variable is an estimate of the amount of time a potential receptor will remain at or near a DEW Line installation over a lifetime. For the DEW Line worker the exposure duration is an estimate of the maximum tour of duty at an installation. A conservative estimate of the duration of a tour at a particular installation is 10 years. For the potential native receptor, a conservative estimate of exposure duration is 55 years based on the assumption that the site use will be residential. EPA's default reasonable maximum exposure duration is 30 years; however, this is based on the overall U.S. population. Because the Alaskan natives are more likely to remain in their village for a longer period, 55 years was determined to be a more appropriate estimate based on best professional judgement.

2.2.3.4 Averaging Time. The averaging time represents the period over which exposure is averaged and is based on the assumption that intermittent exposure at a given contaminant concentration is equivalent to a continuous exposure at a lower concentration. For the DEW Line worker, the averaging time is based on the EPA default lifetime of 70 years for evaluation of

carcinogens, and 10 years (equivalent to the exposure duration) for the evaluation of noncarcinogens. For the native northern adult an averaging time of 70 years for carcinogens was also chosen. To evaluate exposure to noncarcinogens in soil and sediment for the native northern adult and child, an averaging time of 49 years as an adult and 6 years as a child was used (to account for 55 year total exposure). To evaluate the exposure of native northern receptors to noncarcinogens in water an averaging time of 55 years was used.

2.2.3.5 Ingestion of Locally Produced Meat, Fish, and Vegetation. The food supplies of DEW Line installation workers are largely imported from outside the area. Occasionally, a worker would be expected to ingest a locally caught fish or game animal, but the frequency and magnitude of this ingestion is expected to have a negligible effect on exposure to the COCs. Food supplies for the residents of the North Slope are imported from outside the area, and some reports indicate that the reliance on hunting and fishing for subsistence is decreasing as the economy moves from subsistence to wage labor (Chance 1990). Although Inupiats in general have less time to hunt and fish than in the past, up to 50 percent of the food may derive from subsistence activities (Harcharek 1994). Most of the hunting and fishing occurs away from the Oliktok Point DEW Line installation in areas unaffected by the installation. It is not likely that contamination observed at the installation has affected the mammals, birds, and vegetation that may be collected for consumption on the North Slope. Therefore, the consumption of locally produced food is unlikely to pose a significant risk of adverse health effects and will not be considered a complete exposure pathway. The ERA, Section 3.0, presents a detailed assessment of risks to ecological receptors.

2.2.3.6 Soil Ingestion Rate. A conservative approach to estimating the soil ingestion rate is to assume that the EPA default soil ingestion rate of 50 mg/kg for workers (EPA 1991a) and 100 mg/day for adults in a residential setting is applicable to the Oliktok Point installation. The EPA default soil ingestion rate for children is 200 mg/day; this is the recommended value for the risk assessment.

2.2.3.7 Drinking Water Ingestion Rate. There are no circumstances at the Oliktok Point installation that would invalidate the EPA default adult drinking water ingestion rate of 2 L/day. Therefore, this is the recommended value for both workers and natives. However in most, if not all, cases drinking water is imported from offsite, so this may not be a complete route of exposure.

By convention (EPA 1989a), noncancer hazard and cancer risk associated with the drinking water pathway are evaluated for an adult receptor, not a child (Table 2-5). The basis for this approach is that the ratio of drinking water ingestion rate to body weight is assumed to remain relatively constant from childhood to adulthood.

2.2.3.8 Dermal Contact with Soil Rate. Because of the harsh North Slope weather, potential receptors (both workers and natives) are expected to be heavily clothed and gloved. Observations made by RI field personnel indicate that potential human receptors were heavily clothed during the months of the field investigations (August and September 1993). Therefore, dermal exposure to contaminated soils is considered negligible. In addition, the duties of installation workers that involve soil work (excavating, grading, etc.) are conducted in equipment

with enclosed cabs. Thus a dermal contact rate does not appear to be necessary for the exposure assessment.

2.2.3.9 Inhalation Rate. The inhalation pathway is not complete (Section 2.2.1.2), so no estimate for this variable is necessary.

2.2.3.10 Body Weight. There are no circumstances at the Oliktok Point installation that would invalidate the EPA default adult body weight of 70 kg. Therefore, this is the recommended value for both workers and residents of the North Slope. The recommended body weight for children is the EPA default value of 15 kg.

2.2.4 Quantifying Exposure

For each complete, or potentially complete, exposure pathway at the Oliktok Point installation (soils and drinking water ingestion), the ADD for estimating noncancer hazards and the lifetime average daily dose (LADD) for estimating excess lifetime cancer risk were calculated. The equations used for the calculation of ADD and LADD are presented in Table 2-6.

The exposure assumptions assigned to each variable in these equations are presented in Table 2-5. The estimates of ADD and LADD for the COCs at each site are presented in the risk characterization spreadsheets in Appendix A.

2.3 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to weigh available evidence regarding the potential for particular contaminants to cause adverse effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure to a contaminant and the increased likelihood or severity of adverse effects or both. This is done separately for noncarcinogenic effects (Section 2.3.1) and carcinogenic effects (Section 2.3.2). Toxicity summaries are presented in Section 2.3.3.

Toxicity assessment for environmental contaminants generally is accomplished in two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining whether exposure to an agent can cause an increase in the incidence of a particular adverse health effect (e.g., cancer, birth defects) and whether the adverse health effect is likely to occur in humans. Hazard identification involves characterizing the nature and strength of the evidence of causation. Dose-response evaluation is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values (e.g., reference doses and slope factors) are derived that can be used to estimate the incidence or potential for adverse effects as a function of human exposure to the agent. These toxicity values are used in the risk characterization step to estimate the likelihood of adverse effects occurring in humans at particular exposure levels.

TABLE 2-6. EQUATIONS USED FOR ESTIMATING POTENTIAL DOSE

EXPOSURE ROUTE	EQUATION	PARAMETER DEFINITIONS
Ingestion of Soil	Native Northern Adults/Children $ADD \text{ or } LADD\ (mg/kg/day) = \frac{C_s * CF * EF}{AT} \sum_{i=1}^{n} \frac{IR_i * ED_i}{BW_i}$ DEW Line workers: $ADD \text{ or } LADD\ (mg/kg/day) = \frac{C_s * CF * IR * EF * ED}{BW * AT}$	C_s = concentration in soil (mg/kg) CF = conversion factor (10^{-6} kg/mg) IR = ingestion rate (mg/day) EF = exposure frequency (days/year) ED = exposure duration (years) BW = body weight (kg) AT = averaging time (days/year x years)
Ingestion of Surface Water	$ADD \text{ or } LADD\ (mg/kg/day) = \frac{C_w * CF * IR * EF * ED}{BW * AT}$	C_w = concentration in surface water (µg/L) CF = conversion faction (10^{-3} mg/µg) IR = ingestion rate (L/day) EF = exposure frequency (days/year) ED = exposure duration (years) BW = body weight (kg) AT = averaging time (days/year x years)

2.3.1 Toxicity Assessment for Noncarcinogenic Effects

A reference dose, or RfD, is the toxicity value used most often in evaluating noncarcinogenic effects resulting from exposures at contaminated sites. Various types of RfDs are available depending on the exposure route (oral or inhalation), the critical effect (developmental or other), and the length of exposure being evaluated (chronic, subchronic, or single event). The oral RfDs used to estimate the noncancer hazard associated with exposure to soils, sediments, and surface water at the Oliktok Point installation are presented in Table 2-7.

A chronic RfD is defined as an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. Chronic RfDs are developed specifically to be protective for long-term exposure to a compound. Chronic RfDs generally should be used to evaluate the potential noncancerous effects associated with exposure periods between seven years (approximately 10 percent of a human lifetime) and a lifetime. Many chronic RfDs have been reviewed and verified by the intra-agency RfD Workgroup and entered into EPA's IRIS database.

2.3.1.1 Concept of Threshold. To limit noncancerous effects, humans and other animals have protective mechanisms that must be overcome before an adverse effect is manifested. For example, where a large number of cells perform the same or similar function, the cell population may have to be significantly depleted before the adverse effect is seen. As a result, a range of exposures from zero to some finite level exists that can be tolerated by the organism with essentially no chance of expression of adverse effects. In developing a toxicity value for evaluating noncancerous effects (i.e., an RfD), the approach is to identify the upper bound of this tolerance range (i.e., the maximum subthreshold level). Because variability exists among humans, attempts are made to identify a subthreshold level that protects sensitive individuals in the population. For most chemicals, this level can only be estimated; the RfD incorporates uncertainty factors indicating the degree of extrapolation used to derive the estimated value. RfD summaries in IRIS also contain a statement expressing the overall confidence that the evaluators have in the RfD (high, medium, or low). The RfD is generally considered to have uncertainty spanning an order of magnitude or more, so the RfD should not be viewed as a strict scientific demarcation between levels that are toxic and nontoxic.

2.3.2 Toxicity Assessment For Carcinogenic Effects

A slope factor and the accompanying weight-of-evidence determination are the toxicity data most commonly used to evaluate potential human carcinogenic risks. The methods EPA uses to derive these values are outlined below. Additional information can be obtained by consulting EPA's *Guidelines for Carcinogen Risk Assessment* (EPA 1986a) and IRIS Background Document #2 (IRIS 1995). The slope factors for the COCs at Oliktok Point are presented in Table 2-8.

2.3.2.1 Concept of Nonthreshold Effects. Risk evaluation based on the presumption of a dose-response threshold is generally thought to be inappropriate for carcinogenesis. In the evaluation of carcinogens, EPA assumes that a small number of molecular events can evoke changes in a single cell that lead to uncontrolled cellular proliferation and eventually to clinical

TABLE 2-7. TOXICITY CRITERIA FOR NONCANCER EFFECTS OF THE CHEMICALS OF CONCERN FOR OLIKTOK POINT

CHEMICAL	ORAL REFERENCE DOSE (RfD) (mg/kg-day)	TARGET ORGAN OR CRITICAL EFFECT (species)[a]	UNCERTAINTY FACTOR[b]	ORAL RfD SOURCE[c]
Aroclor 1254	0.00002	Ocular exudate meibomian gland inflammation, distorted nail growth, immunological effects (monkeys)	300	IRIS
Barium	0.07	NOAEL (humans)	3	IRIS
Benzene	NA	NA	NA	IRIS
Bis(2-ethylhexyl)phthalete	0.02	Increased relative liver weight (guinea pigs)	1,000	IRIS
Copper	0.037	Gastrointestinal irritation (humans)	NA	HEAST
1,2-Dichloroethane	NA	NA	NA	IRIS
DRPH	0.08[d]	liver effects (mice)	10,000	ECAO
GRPH	0.2[d]	decreased body weight (rats)	1000	ECAO
Manganese (water)	0.005	CNS effects (humans)	1	IRIS
Lead	NA	NA	NA	IRIS
RRPH	0.08[d]	liver effects (mice)	10,000	ECAO
Tetrachloroethene	0.01	liver effects (mice)	1,000	IRIS
Vanadium	0.007	NOAEL (rats)	100	HEAST

a A target organ is the organ apparently most sensitive to the toxicity of a chemical. A critical effect is reported when EPA has not identified a target organ for the toxicity of a given chemical.
b The uncertainty factors used to develop oral reference doses are generally applied in multiples of 10 to account for shortcomings in the toxicological database. The greater the uncertainty factor, the lower the confidence level in the RfD. Factors of 10 are applied to account for each of the following sources of uncertainty in toxic response, extrapolation from animal studies to humans, extrapolation of short-term exposures to long-term exposures, and the extrapolation of a lowest-observed adverse effect level (LOAEL) to a no observed adverse effect level (NOAEL).
c Sources of oral RfD values are IRIS (Integrated Risk Information System), HEAST (Health Effects Assessment Summary Tables), or ECAO (The Environmental Criteria and Assessment Office of EPA).
d Oral RfD values for DRPH, GRPH, and RRPH are based on (EPA 1992b) and are considered provisional.
NA Not available.
NOAEL No observed adverse effects level.

TABLE 2-8. TOXICITY VALUES FOR THE CARCINOGENICITY OF THE CHEMICALS OF CONCERN AT OLIKTOK POINT

CHEMICAL	WEIGHT-OF-EVIDENCE (WOE)	TUMOR TYPE (species)	ORAL SLOPE FACTOR (kg-day/mg)	ORAL SLOPE FACTOR SOURCE[a]
Aroclor 1254 (PCBs)	B2	trabecular carcinoma/adeno-carcinoma, neoplastic modules (rats)	7.7	IRIS
Barium	NA	NA	NA	IRIS
Benzene	A	leukemia (humans)	0.029	IRIS
Bis(2-ethylhexyl)phthalete	B2	hepatocellular carcinoma and adenoma	0.014	IRIS
Copper	D	NA	NA	IRIS
1,2-Dichloroethane	B2	hemangiosarcomas (rats)	0.091	IRIS
DRPH	NA	NA	NA	NA
GRPH	C	liver adenoma/carcinoma (mouse)	0.0017	ECAO
Lead	B2	NA	NA	IRIS
Manganese (water)	D	NA	NA	IRIS
RRPH	NA	NA	NA	NA
Tetrachloroethene	C-B2	not specified	0.052	ECAO
Vanadium	NA	NA	NA	NA

a IRIS, Integrated Risk Information System; ECAO, Environmental Criteria and Assessment Office of EPA.
NA Not available.

state of disease (cancer). This hypothesized mechanism for carcinogenesis is referred to as "nonthreshold" because all levels of exposure pose a finite probability of causing the development of cancer. No dose is thought to be risk-free and an effect threshold cannot be estimated. For carcinogens, EPA uses a two-part evaluation in which the substance first is assigned a weight-of-evidence classification, and then a slope factor is calculated.

2.3.2.2 Assigning a Weight-of-Evidence. In the first step of the evaluation, the carcinogenicity data are evaluated to determine the likelihood that the agent is a human carcinogen. The evidence is characterized separately for human studies and animal studies as sufficient, limited, inadequate, no data, or evidence of no effect. The characterizations of these two types of data are combined, and based on the extent to which the agent has been shown to be a carcinogen in experimental animals, humans, or both, the agent is given a provisional weight-of-evidence classification. EPA scientists then adjust the provisional classification upward or downward based on other supporting evidence of carcinogenicity.

The EPA classification system for weight-of-evidence is shown in Table 2-9.

2.3.2.3 Generating a Slope Factor. For chemicals classified as known or probable human carcinogens, a toxicity value that defines quantitatively the relationship between dose and response (i.e., the slope factor) is calculated. Slope factors typically are calculated for potential carcinogens in classes A, B1, and B2. Quantitative estimation of slope factors for the chemicals in class C is done on a case-by-case basis.

Generally, the slope factor is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used in risk assessments to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. Slope factors (SFs) should always be accompanied by the weight-of-evidence classification to indicate the strength of the evidence that the agent is a human carcinogen.

2.3.2.4 Identifying the Appropriate Data Set. In deriving slope factors, the available information about a chemical is evaluated, and an appropriate data set is selected. Human data of high quality are preferable to animal data. If animal data are used, the species that responds most similarly to humans (with respect to factors such as metabolism, physiology, and pharmacokinetics) is preferred. When no clear choice is possible, the most sensitive species is given the greatest emphasis. Occasionally, in situations where no single study is judged most appropriate yet several studies collectively support the estimate, the geometric mean of estimates from all studies may be adopted as the slope factor. This practice ensures the inclusion of all relevant data.

2.3.2.5 Extrapolating to Lower Doses. Because risk at low exposure levels is difficult to measure directly either by animal experiments or by epidemiologic studies, the development of a slope factor generally entails applying a model to the available data set and using the model to extrapolate from the relatively high doses administered to experimental animals (or the exposures noted in epidemiologic studies) to the lower exposure levels expected for human contact in the environment.

TABLE 2-9. EPA WEIGHT-OF-EVIDENCE CLASSIFICATION SYSTEM FOR CARCINOGENICITY

GROUP	DESCRIPTION
A	Human carcinogen.
B1 or B2	Probable human carcinogen.
	B1 indicates that limited human data are available.
	B2 indicates sufficient evidence in animals and inadequate or no evidence in humans.
C	Possible human carcinogen.
D	Not classifiable as to human carcinogenicity.
E	Evidence of noncarcinogenicity for humans.

A number of mathematical models and procedures have been developed to extrapolate from carcinogenic responses observed at high doses to responses expected at low doses. Different extrapolation methods may provide a reasonable fit to the observed data but may lead to large differences in the projected risk at low dose.

In general, after the data are fit to the appropriate model, the upper 95th percent confidence limit of the slope of the resulting dose-response curve is calculated. This value is known as the slope factor and represents an upper 95th percent confidence limit on the probability of a response per unit intake of a chemical over a lifetime (i.e., there is only a five percent chance that the probability of a response could be greater than the estimated value on the basis of the experimental data and model used). In some cases, slope factors based on human dose-response data are based on the "best" estimate instead of the upper 95th percent confidence limits. Because the dose-response curve generally is linear only in the low-dose region, the slope factor estimate only holds true for low doses. Information concerning the limitations on use of slope factors can be found in IRIS.

2.3.2.6 Summary of Dose-Response Parameters. Toxicity values for carcinogenic effects can be expressed in several ways. The slope factor generally is considered to be the upper 95th percent confidence limit of the slope of the dose-response curve and is expressed as $(mg/kg\text{-}day)^{-1}$. Thus:

$$\begin{aligned}\text{Slope factor} &= \text{risk per unit dose}\\ &= \text{risk per mg/kg-day}\end{aligned}$$

Where data permit, slope factors listed in IRIS are based on absorbed doses, although many of them have been based on administered doses.

2.3.3 Summaries of the Toxicity of the Chemicals of Concern

Tables 2-7 and 2-8 present chronic cancer and noncancer health effects criteria (oral slope factors and RfDs, respectively, for the COCs). The toxicological properties of the COCs and the toxicological basis of the health effects criteria listed in Tables 2-7 and 2-8 are discussed in Appendix B.

2.4 RISK CHARACTERIZATION

In the risk characterization, the toxicity and exposure assessments are summarized and integrated into quantitative and qualitative expressions of risk. To characterize potential noncancerous effects, comparisons are made between projected intakes (ADD) of substances and toxicity values (e.g., the reference dose). To characterize potential carcinogenic effects, probabilities that an individual will develop cancer over a lifetime of exposure are estimated from projected intakes (LADD) and chemical-specific dose-response information (e.g., the slope factor). Major assumptions, scientific judgements, and to the extent possible, estimates of the uncertainties embodied in the assessment are also presented. In this section, methods of quantifying risks are discussed and applied to individual sites at the Oliktok Point installation.

2.4.1 Quantifying Risks

This section describes the steps for quantifying risk or hazard indices for both carcinogenic and noncancerous effects to be applied to each exposure pathway analyzed. The first two subsections cover procedures for individual substances and are followed by a subsection on procedures for quantifying risks associated with simultaneous exposures to several substances.

2.4.1.1 Risks from Individual Substances - Carcinogenic Effects. For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen (i.e., incremental or excess individual lifetime cancer risk). The guidelines provided in this section are consistent with EPA's guidance (EPA 1986a). For some carcinogens, there may be sufficient information on mechanism of action that a modification of the approach outlined below is warranted. Alternative approaches may be considered in consultation with ECAO on a case-by-case basis.

The slope factor converts estimated daily intakes averaged over a lifetime of exposure directly to incremental risk of an individual developing cancer. Because environmental exposure is likely to result in relatively low intakes (compared to those experienced by test animals), it generally can be assumed that the dose-response relationship will be linear in the low-dose portion of the multistage model dose-response curve. Under this assumption, the slope factor is a constant, and risk will be directly related to intake. Thus, the linear form of the carcinogenic risk equation is usually applicable for estimating cancer risks. This linear low-dose equation is described below.

LINEAR LOW-DOSE CANCER RISK EQUATION

Risk = LADD x SF

where:

Risk = a unitless probability (e.g., 2×10^{-5}) of an individual developing cancer;

LADD = lifetime average daily dose averaged over 70 years (mg/kg-day); and

SF = slope factor, expressed in $(mg/kg\text{-}day)^{-1}$.

Because the slope factor is often an upper 95th percentile confidence limit of the probability of response based on experimental animal data used in the multistage model, the carcinogenic risk estimate generally will be an upper-bound estimate. This means that the "true risk" will probably not exceed the risk estimate derived through use of this model and is likely to be lower than predicted.

2.4.1.2 Noncancer Hazards from Individual Substances - Noncancerous Effects. The measure used to describe the potential for noncancerous toxicity in an individual is not expressed as the probability of an individual suffering an adverse effect. EPA does not at the present time use a probabilistic approach to estimate the potential for noncancerous health effects. Instead, the potential for noncancerous effects is evaluated by comparing an exposure level over a specified time period (e.g., some fraction of a lifetime) with a reference dose derived for a similar exposure period. This ratio of exposure to toxicity is called a hazard quotient (HQ).

The noncancer hazard quotient assumes there is a level of exposure (i.e., the RfD) below which it is unlikely even for sensitive populations to experience adverse health effects. If the exposure level (ADD) exceeds this threshold (i.e., if ADD/RfD exceeds unity), there may be concern for potential noncancer effects. As a rule, the greater the value of ADD/RfD above unity, the greater the level of concern. Ratios of ADD/RfD should not be interpreted as statistical probabilities; a ratio of 0.001 does not mean that there is a one in one thousand chance of the effect occurring. Further, it is important to emphasize that the level of concern does not increase linearly as the RfD is approached or exceeded because RfDs do not have equal accuracy or precision and are not based on the same severity of toxic effects. Thus, the slopes of the dose-response curve in excess of the RfD can range widely depending on the substance.

NONCANCER HAZARD QUOTIENT

Noncancer Hazard Quotient = ADD/RfD

where:

ADD = average daily dose (or intake) and

RfD = reference dose.

ADD and RfD are expressed in the same units and represent the same exposure period (e.g., chronic, subchronic, or short-term).

2.4.1.3 Aggregate Risks for Multiple Substances. Estimating risk or hazard potential by considering one chemical at a time might significantly underestimate the risks associated with simultaneous exposures to several substances. To assess the overall potential for cancer and noncancer effects posed by multiple chemicals, EPA has developed *Guidelines for the Health Risk Assessment of Chemical Mixtures* (EPA 1986b). These guidelines can be applied to the case of simultaneous exposures to several chemicals from a variety of sources by more than one exposure pathway. Information on specific mixtures is rarely available. Even if such data exist, they are often difficult to use. Monitoring for "mixtures" or modeling the movement of mixtures across space and time present significant technical problems given the likelihood that individual components will behave differently in the environment (i.e., fate and transport).

Although the calculation procedures differ for carcinogenic and noncarcinogenic effects, both sets of procedures assume dose additivity in the absence of information on specific mixtures.

Carcinogenic effects. The cancer risk equation described below is used to estimate the incremental individual lifetime cancer risk for simultaneous exposure to several carcinogens based on EPA's risk assessment guidelines. This equation represents an approximation of the precise equation for combining risks that accounts for the joint probabilities of the same individual developing cancer as a consequence of exposure to two or more carcinogens. The difference between the precise equation and the approximation described in the equation below is negligible for total cancer risks less than 0.1. Thus, the simple additive equation is appropriate for most risk assessments.

CANCER RISK EQUATION FOR MULTIPLE SUBSTANCES

$$Risk_T = \Sigma \, Risk_i$$

where:

$Risk_T$ = the total cancer risk, expressed as a unitless probability and

$Risk_i$ = the risk estimate for the i^{th} substance.

The risk summation techniques described in the cancer risk equation above assume that intakes of individual substances are small. They also assume independence of action by the compounds involved (i.e., there are no synergistic or antagonistic chemical interactions and all chemicals produce the same effect, i.e., cancer). If these assumptions are incorrect, over- or under-estimation of the actual multiple-substance risk could result.

A separate total cancer risk for each exposure pathway is calculated by summing the substance-specific cancer risks. Resulting cancer risk estimates should be expressed using one significant figure only.

There are several limitations to this approach. First, because each slope factor is an upper 95th percentile estimate of potency and upper 95th percentiles of probability distributions are not strictly additive, the total cancer risk estimate might artificially become more conservative as risks from a number of different carcinogens are summed. If one or two carcinogens drive the risk, however, this problem is not of concern. Second, it often will be the case that substances with

different weights of evidence for human carcinogenicity are included. The cancer risk equation for multiple substances sums all carcinogens equally, giving as much weight to class B or C as to class A carcinogens. In addition, slope factors derived from animal data will be given the same weight as slope factors derived from human data. Finally, the action of two different carcinogens might not be independent.

Noncancerous effects. To assess the overall potential for noncancerous effects posed by more than one chemical, a hazard index approach has been developed based on EPA's *Guidelines for Health Risk Assessment of Chemical Mixtures* (EPA 1986b). This approach assumes that simultaneous subthreshold exposures to several chemicals could result in an adverse health effect. It also assumes that the magnitude of the adverse effect will be proportional to the sum of the ratios of the subthreshold exposures. The hazard index (HI) is equal to the sum of the hazard quotients. When the hazard index exceeds unity, there may be concern for potential health effects. Any single chemical with an exposure level greater than the toxicity value will cause the hazard index to exceed unity, and for multiple chemical exposures, the hazard index can exceed unity even if no single chemical exposure exceeds its RfD. The equation used to determine noncancer hazard index is as follows:

NONCANCER HAZARD INDEX

$$\text{Hazard Index} = ADD_1/RfD_1 + ADD_2/RfD_2 + \ldots + ADD_i/RfD_i$$

where:

ADD_i = average daily dose (or intake) for the i^{th} toxicant;

RfD_i = reference dose for the i^{th} toxicant; and

ADD and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or shorter-term).

Where appropriate, a separate chronic hazard index can be calculated from the ratios of the chronic daily intake (CDI) to the chronic RfD for individual chemicals as described below.

CHRONIC NONCANCER HAZARD INDEX

$$\text{Chronic Hazard Index} = LADD_1/RfD_1 + LADD_2/RfD_2 + \ldots + LADD_i/RfD_i$$

where:

$LADD_i$ = lifetime average daily dose for the i^{th} toxicant in mg/kg-day and

RfD_i = chronic reference dose for the i^{th} toxicant in mg/kg-day.

There are several limitations to this approach. As mentioned earlier, the level of concern does not increase linearly as the reference dose is approached or exceeded because the RfDs do not have equal accuracy or precision and are not based on the same severity of effect. Moreover, hazard quotients are combined for substances with RfDs based on critical effects of varying toxicological significance. It will often be the case that RfDs of varying levels of confidence, including different uncertainty adjustments and modifying factors, will be combined (e.g.,

extrapolation from animals to humans, from LOAELs to NOAELs, and from one exposure duration to another).

Another limitation with the hazard index approach is that the assumption of dose additivity is most properly applied to compounds that induce the same effect by the same mechanism of action. Consequently, application of the hazard index equation to a number of compounds that are not expected to induce the same type of effects or that do not act by the same mechanism could overestimate the potential for effects. Such an approach is, however, appropriate at a screening level. This possibility is generally not of concern if only one or two substances are responsible for driving the hazard index above unity. If the hazard index is greater than unity as a consequence of summing several hazard quotients of similar value, it is appropriate to segregate the compounds by effect and by mechanism of action and derive separate hazard indices for each group.

2.4.2 Site-Specific Risk Characterization

Soil and Sediment Exposures. The quantification of noncancer hazard and excess lifetime cancer risk associated with the soil ingestion pathway at the Oliktok Point installation was based on analytical data from soil and sediment samples collected within the interval from ground surface to permafrost. No attempt was made to segregate surface soil samples from subsurface samples in the human health risk characterization.

The noncancer hazard and the excess lifetime cancer risk associated with the ingestion of soil or sediment containing COCs has been estimated for a hypothetical native northerner based on six years of exposure as a child and 49 years of exposure as an adult; for cancer risk the exposure was averaged over 70 years. For the DEW Line worker, cancer risk has been estimated based on ten years of exposure averaged over a default lifetime of 70 years. Noncancer hazard for the DEW Line worker was based on a 10 year exposure.

Surface Water Exposures. The noncancer hazard and the excess lifetime cancer risk associated with the ingestion of surface water containing COCs has been estimated based on a native northern adult and a DEW Line worker. A native northern child receptor was not considered because, unlike exposure to soil, which is expected to be greater in a child than in an adult, the ratio of drinking water ingestion rate to body weight is assumed to be relatively constant from childhood to adulthood. A greater number of years is spent as an adult, so estimating hazard or risk for water ingestion based on an adult is a more conservative approach. The exposure duration estimate for the DEW Line worker was 10 years and for the native northern adult was 55 years. Exposures were averaged over 10 years for DEW Line worker exposure to noncarcinogens, and 55 years for native northern adult exposure to noncarcinogens. Exposures were averaged over 70 years for both receptor groups to characterize the risk associated with exposure to carcinogens in surface water.

Ingestion of surface water at the Oliktok Point installation is not considered to be a complete pathway under a current use scenario. Surface water at each of the sites investigated is not a reliable source for domestic or occupational use; this water is frozen most of the year. Furthermore, potable water is supplied by a freshwater lake located upgradient and offsite in an

area not expected to be impacted by installation operations. Under a future use scenario, however, it is possible that the buildings could be used for residences or additional residential structures could be erected at the installation. The future residents could be either DEW Line workers or native northerners. Therefore, because sources of water may change in the future, potential ingestion of surface water at the installation will be evaluated for the DEW Line worker and native northern adult under a future use exposure scenario only.

Table 2-10 contains a site-by-site summary of the COCs in each medium, and the noncancer hazard and excess lifetime cancer risk associated with exposure to the COCs in the soils, sediments, and surface water. Table 2-10 does not include media where no COCs were identified, for example, soil/sediment and surface water at the Dump Site (LF02). COCs without toxicity data are not included on Table 2-10, but are discussed in Section 2.1.5. Appendix A contains the spreadsheets used to calculate the noncancer hazard and excess lifetime cancer risk estimates presented in Table 2-10.

Risk Characterization of Petroleum Hydrocarbons. Petroleum hydrocarbons represent a primary source of contamination at the Oliktok Point installation. The laboratory analysis of soil, sediment, and surface water samples revealed the presence of DRPH, GRPH, and RRPH. To characterize the risk associated with exposure to these compounds, the provisional reference doses and the slope factor developed by EPA for petroleum hydrocarbons were applied (EPA 1992b). These provisional RfDs provide the best available tool for characterizing the risk associated with exposure to the petroleum hydrocarbons. The RfD for JP-4 documented by EPA (EPA 1992b) was used to represent DRPH and RRPH, and the RfD and slope factor for unleaded gasoline were used to represent GRPH.

The noncancer hazard associated with exposure to DRPH, GRPH, and RRPH was, therefore, estimated by dividing the compound- and site-specific ADD by the appropriate provisional RfD (EPA 1992b). The excess lifetime cancer risk associated with exposure to GRPH was estimated by multiplying the compound- and site-specific LADD by the slope factor for unleaded gasoline (EPA 1992b).

Although the provisional RfDs and slope factor represent the best available numerical estimate of toxicity, there is a significant amount of uncertainty associated with their use at the Oliktok Point installation. The RfDs and slope factor are based on studies in mice and rats by the inhalation route of exposure; however, for this risk assessment, exposure of humans by the ingestion route is being evaluated. Furthermore, in the absence of a more thorough study to compare the DRPH, GRPH, and RRPH to known petroleum refinery streams, it is not clear how well the provisional values represent the toxicity of diesel and gasoline in humans.

Risk Characterization of Chemicals Detected. Chemicals detected above background levels without RBSLs or ARARs are evaluated in Section 2.1.5 (page 2-9). Based on the information in that section, and the relatively low levels detected at the sites, these chemicals are not expected to pose a health risk. Risk characterization of chemicals detected that exceed RBSLs, ARARs, or both are discussed on a site-by-site basis below.

TABLE 2-10. SUMMARY OF NONCANCER HAZARD AND EXCESS LIFETIME CANCER RISK FOR OLIKTOK POINT

SITE	MEDIUM	NONCANCER CHEMICALS OF CONCERN[a]	NONCANCER HAZARD[c] DEW LINE WORKER	NONCANCER HAZARD[c] NATIVE NORTHERN ADULT	NONCANCER HAZARD[c] NATIVE NORTHERN ADULT/CHILD	CARCINOGENIC CHEMICALS OF CONCERN[a]	EXCESS LIFETIME CANCER RISK[d] DEW LINE WORKER	EXCESS LIFETIME CANCER RISK[d] NATIVE NORTHERN ADULT	EXCESS LIFETIME CANCER RISK[d] NATIVE NORTHERN ADULT/CHILD
Old Landfill (LF01)	Soil or Sediment	Aroclor 1254	0.004	---[e]	0.08	Aroclor 1254 (PCBs)	5×10^{-7}	---	**1×10^{-5}**
	Surface Water	GRPH	0.005	0.005	---[f]	GRPH	2×10^{-7}	1×10^{-6}	---
Dump Site (LF02)	Soil or Sediment	---[b]	---	---	---	---	---	---	---
	Surface Water	---	---	---	---	---	---	---	---
Dock Storage Area (ST03)	Soil or Sediment	Aroclor 1254	0.001	---	0.02	Aroclor 1254 (PCBs)	2×10^{-8}	---	4×10^{-7}
	Surface Water	DRPH	0.1	0.1	---	1,2-Dichloroethane	3×10^{-7}	**2×10^{-6}**	---
POL Storage (ST04)	Soil or Sediment	---	---	---	---	---	---	---	---
	Surface Water	---	---	---	---	---	---	---	---
Diesel Spill (SS05)	Soil or Sediment	DRPH GRPH	0.01	---	0.3	GRPH	6×10^{-9}	---	1×10^{-7}
	Surface Water	DRPH	0.08	0.08	---	---	---	---	---
Gasoline Storage Area (ST08)	Soil or Sediment	DRPH GRPH RRPH	0.2	---	**5**	GRPH Benzene	3×10^{-8}	---	7×10^{-7}
	Surface Water	bis(2-Ethylhexyl)phthalate	0.03	0.03	---	1,2-Dichloroethane bis(2-Ethylhexyl)phthalate	**2×10^{-6}**	**8×10^{-6}**	---
Garage (SS10)	Soil or Sediment	DRPH GRPH RRPH Tetrachloroethene bis(2-Ethylhexyl)phthalate Aroclor 1254	0.1	---	**2**	GRPH Benzene Tetrachloroethene bis(2-Ethylhexyl)phthalate Aroclor 1254	2×10^{-7}	---	**5×10^{-6}**
	Surface Water	Barium	0.06	0.06	---	---	---	---	---

TABLE 2-10. SUMMARY OF NONCANCER HAZARD AND EXCESS LIFETIME CANCER RISK FOR OLIKTOK POINT (CONTINUED)

SITE	MEDIUM	NONCANCER CHEMICALS OF CONCERN[a]	NONCANCER HAZARD[c]			CARCINOGENIC CHEMICALS OF CONCERN[a]	EXCESS LIFETIME CANCER RISK[d]		
			DEW LINE WORKER	NATIVE NORTHERN ADULT	NATIVE NORTHERN ADULT/CHILD		DEW LINE WORKER	NATIVE NORTHERN ADULT	NATIVE NORTHERN ADULT/CHILD
Old Sewage Area Petroleum Spill (SS11)	Soil or Sediment	DRPH GRPH Aroclor 1254	0.004	---	0.08	GRPH Aroclor 1254	8×10^{-9}	---	2×10^{-7}
	Surface Water	DRPH GRPH Barium Copper Manganese Vanadium	**8**	**8**	---	GRPH 1,2-Dichloroethane	1×10^{-6}	**6×10^{-6}**	---

BOLD Bold text indicates that the value exceeds a noncancer hazard index of 1.0 or an excess lifetime cancer risk of 1×10^{-6}.

--- Not applicable because no chemicals of concern identified.

a All COCs are listed together regardless of whether they contribute to the hazard index, cancer risk, or both.

b None, no COCs selected.

c Hazard index, noncancer hazard index. The hazard index is the sum of the HQs for all of the COCs associated with a given medium, pathway, and receptor group.

d Cancer risk, excess lifetime cancer risk. The cancer risk is the sum of the excess lifetime cancer risks for all of the carcinogenic COCs associated with a given medium, pathway, and receptor group.

e Children are assumed to have a soil ingestion rate greater than that for adults. Therefore, under a residential scenario, the estimates of noncancer hazard and cancer risk associated with soil ingestion are estimated for a combined adult and child receptor only. This estimate is considered a conservative upper bound on the true hazard or risk.

f Drinking water ingestion, unlike soil ingestion, is evaluated for an adult receptor but not a child receptor because adults are assumed to have a longer exposure duration at a greater water ingestion rate. Therefore, the hazard or risk estimated will represent an upper bound, conservative estimate. For soil ingestion, the child soil ingestion rate is assumed to exceed that for adults. Therefore, a combination of the adult and child receptor groups is used to evaluate soil ingestion risk and hazard.

2.4.2.1 Old Landfill (LF01).

Soils or Sediments. The noncancer hazard associated with the ingestion of soil at the Old Landfill by a hypothetical native northern adult/child is 0.08 and by a DEW Line worker is 0.004, based on the maximum concentration of the COC (Tables 2-10 and A-1). The presence of Aroclor 1254 accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations.

The excess lifetime cancer risk associated with the ingestion of soil at the Old Landfill by a hypothetical native northern adult/child is 1×10^{-5}, and by a DEW Line worker is 5×10^{-7}, based on the maximum concentration of the COC (Tables 2-10 and A-2). The presence of Aroclor 1254 accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

Surface Water. The noncancer hazard associated with the ingestion of surface water at the Old Landfill by a hypothetical native northern adult or a DEW Line worker is 0.005, based on the maximum concentration of GRPH (Tables 2-10 and A-3). The presence of GRPH accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations.

The excess lifetime cancer risk associated with the ingestion of surface water at the Old Landfill by a hypothetical native northern adult is 1×10^{-6}, and by a DEW Line worker is 2×10^{-7}, based on the maximum concentration of the COC (Tables 2-10 and A-4). The presence of GRPH accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

2.4.2.2 Dump Site (LF02).

Soils or Sediments. No COCs were selected for the soil at the Dump Site (Table 2-1). This does not indicate that exposure to chemicals in the soil at the site is without health risk; however, the concentrations measured were below those considered acceptable under Region 10 guidelines (EPA 1991a) or federal ARARs.

Surface Water. No COCs were identified for the surface water at the Dump Site (Table 2-1). This does not indicate that exposure to chemicals in the surface water at the site is without health risk; however, the concentrations measured were below those considered acceptable under Region 10 guidance (EPA 1991a) or federal ARARs.

2.4.2.3 Dock Storage Area (ST03).

Soils or Sediments. The noncancer hazard associated with the ingestion of soil at the Dock Storage Area by a hypothetical native northern adult/child is 0.02, and by a DEW Line worker is 0.001, based on the maximum concentration of the COC (Tables 2-10 and A-5). The presence of Aroclor 1254 accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations.

The excess lifetime cancer risk associated with the ingestion of soil at the Dock Storage Area by a hypothetical native northern adult/child is 4×10^{-7}, and by a DEW Line worker is 2×10^{-8}, based on the maximum concentration of the COC (Tables 2-10 and A-6). The presence of Aroclor 1254 accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

Surface Water. The noncancer hazard associated with the ingestion of surface water at the Dock Storage Area by a hypothetical native northern adult or a DEW Line worker is 0.1, based on the maximum concentration of DRPH (Tables 2-10 and A-7). The presence of DRPH accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations.

The excess lifetime cancer risk associated with the ingestion of surface water at the Dock Storage Area by a hypothetical native northern adult is 2×10^{-6}, and by a DEW Line worker is 3×10^{-7}, based on the maximum concentration of the COC (Tables 2-10 and A-8). The presence of 1,2-dichloroethane accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

2.4.2.4 POL Storage (ST04).

Soils or Sediments. No COCs were identified for the soils or sediments at the POL Storage (Table 2-1). This does not indicate that exposure to chemicals in the soil at the site is without health risk; however, the concentrations measured were lower than the concentrations considered acceptable under Region 10 guidance (EPA 1991a) or federal ARARs.

Surface Water. No surface water bodies were identified at the POL Storage; therefore, no evaluation of noncancer hazard or excess lifetime cancer risk associated with ingestion of surface water was conducted.

2.4.2.5 Diesel Spill (SS05).

Soils or Sediments. The noncancer hazard associated with the ingestion of soil at the Diesel Spill site by a hypothetical native northern adult/child is 0.3, and by a DEW Line worker is 0.01, based on the maximum concentrations of the COCs (Tables 2-10 and A-9). The presence of DRPH and GRPH accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations.

The excess lifetime cancer risk associated with the ingestion of soil at the Diesel Spill site by a hypothetical native northern adult/child is 1×10^{-7}, and by a DEW Line worker is 6×10^{-9}, based on the maximum concentration of GRPH (Tables 2-10 and A-10). The presence of GRPH accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

Other chemicals detected in the soil or sediment at the site may be carcinogenic or produce noncancer effects; however, the lack of toxicity values (RfDs or slope factors) for these chemicals precludes the quantification of cancer risk or noncancer hazard.

Surface Water. The noncancer hazard associated with the ingestion of surface water at the Diesel Spill site by a hypothetical native northern adult or a DEW Line worker is 0.08, based on the maximum concentration of DRPH (Table 2-19 and A-11). The presence of DRPH accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations.

2.4.2.6 Gasoline Storage Area (ST08).

Soils or Sediments. The noncancer hazard associated with the ingestion of soil at the Gasoline Storage Area by a hypothetical native northern adult/child is 5, and by a DEW Line worker is 0.2, based on the maximum concentrations of the COCs (Tables 2-10 and A-12). The presence of DPRH, GRPH, and RRPH accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations. DRPH alone accounts for more than 99 percent of the noncancer hazard.

The excess lifetime cancer risk associated with the ingestion of soil at the Gasoline Storage Area by a hypothetical native northern adult/child is 7×10^{-7}, and by a DEW Line worker is 3×10^{-8}, based on the maximum concentrations of the COCs (Tables 2-10 and A-13). The presence of GRPH and benzene accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

Surface Water. The noncancer hazard associated with the ingestion of surface water at the Gasoline Storage Area by a hypothetical native northern adult or a DEW Line worker is 0.03, based on the maximum concentration of the COC (Tables 2-10 and A-14). The presence of bis(2-ethylhexyl)phthalate accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations.

The excess lifetime cancer risk associated with the ingestion of surface water at the Gasoline Storage Area by a hypothetical native northern adult is 8×10^{-6}, and by a DEW Line worker is 2×10^{-6}, based on the maximum concentrations of the COCs (Tables 2-10 and A-15). The presence of 1,2-dichloroethane and bis(2-ethylhexyl)phthalate accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

2.4.2.7 Garage (SS10).

Soils or Sediments. The noncancer hazard associated with the ingestion of soil at the Garage by a hypothetical native northern adult/child is 2, and by a DEW Line worker is 0.1, based on the maximum concentrations of the COCs (Tables 2-10 and A-16). The presence of DPRH, GRPH, RRPH, tetrachloroethene, bis(2-ethylhexyl)phthalate, and Aroclor 1254 accounts for the quantifiable noncancer hazard for these receptor/pathway combinations. DRPH and RRPH together account for more than 90 percent of the noncancer hazard.

The excess lifetime cancer risk associated with the ingestion of soil at the Garage by a hypothetical native northern adult/child is 5×10^{-6}, and by a DEW Line worker is 2×10^{-7}, based on the maximum concentrations of the COCs (Tables 2-10 and A-17). The presence of GRPH, benzene, tetrachloroethene, bis(2-ethylhexyl)phthalate, and Aroclor 1254 (a PCB) accounts for

the quantifiable excess lifetime cancer risk for these receptor/pathway combinations. Aroclor 1254 alone accounts for about 90 percent of the cancer risk.

Surface Water. The noncancer hazard associated with the ingestion of surface water at the Garage by a hypothetical native northern adult or a DEW Line worker is 0.06, based on the maximum concentration of the COC (Tables 2-10 and A-18). The presence of barium accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations.

No carcinogenic COCs were identified for the surface water at the Garage; therefore, the excess lifetime cancer risk associated with ingestion of surface water cannot be quantified.

2.4.2.8 Old Sewage Area Petroleum Spill (SS11).

Soils or Sediments. The noncancer hazard associated with the ingestion of soil at the Old Sewage Area Petroleum Spill site by a hypothetical native northern adult/child is 0.08, and by a DEW Line worker is 0.004, based on the maximum concentrations of the COCs (Tables 2-10 and A-19). The presence of DPRH, GRPH, and Aroclor 1254 accounts entirely for the quantifiable noncancer hazard for these receptor/pathway combinations.

The excess lifetime cancer risk associated with the ingestion of soil at the Old Sewage Area Petroleum Spill site by a hypothetical native northern adult/child is 2×10^{-7}, and by a DEW Line worker is 8×10^{-9}, based on the maximum concentration of the COCs (Tables 2-10 and A-20). The presence of GRPH and Aroclor 1254 accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

Surface Water. The noncancer hazard associated with the ingestion of surface water at the Old Sewage Area Petroleum Spill site by a hypothetical native northern adult or a DEW Line worker is 8, based on the maximum concentration of the COCs (Tables 2-10 and A-21). The presence of DRPH, GRPH, barium, copper, manganese, and vanadium accounts for the quantifiable noncancer hazard for these receptor/pathway combinations. Manganese alone accounts for more than 99 percent of the noncancer hazard.

The excess lifetime cancer risk associated with the ingestion of surface water at the Old Sewage Area Petroleum Spill site by a hypothetical native northern adult is 6×10^{-6}, and by a DEW Line worker is 1×10^{-6}, based on the maximum concentrations of the COCs (Tables 2-10 and A-22). The presence of GRPH and 1,2-dichloroethane accounts entirely for the quantifiable excess lifetime cancer risk for these receptor/pathway combinations.

2.5 RISK CHARACTERIZATION UNCERTAINTY

Several sources of uncertainty affect the estimates of excess lifetime cancer risk and noncancer hazard as presented in this risk assessment. The sources are generally associated with:

- Sampling and analysis of soil, sediment, and surface water;

- Assigning the source of contamination;
- Exposure assumptions, including estimates of exposure point concentrations;
- Evaluation of the toxicity of the COCs; and
- Methods and assumptions used to characterize the cancer risk and noncancer hazard.

Uncertainties associated with sampling and analyses include the inherent variability (standard error) in the analyses, representativeness of the samples, sampling errors, and heterogeneity of the sample matrix. The quality assurance/quality control program used in conducting the sampling and analyses serves to reduce errors, but it can not eliminate all errors associated with sampling and analyses. There is some uncertainty in the selection of COCs with respect to sample quantitation limits for a given chemical. In some cases a chemical may have had detected values below the COC screening criteria as well as samples with quantitation limits greater than the screening criteria. In these cases it should be understood that only the samples with adequate quantitation limits are applicable to the screening process. Thus, the number of samples used to screen a chemical would be less than the total number of analyses for that chemical.

Simplifying assumptions were made about the environmental fate and transport of the site contamination, specifically, that no contaminant loss or transformation occurs. Thus, the data chosen to represent exposure point concentrations in the sample-by-sample risk calculations are an additional source of potential error.

The depth at which a soil sample was collected was not considered in the risk characterization, so exposure to subsurface contamination was considered to be equally likely as exposure to surface contamination. This approach would tend to overestimate the true risk.

The estimation of exposure requires many assumptions to describe potential exposure situations. There are uncertainties regarding the likelihood of exposure, frequency of contact with contaminated media, the concentration of contaminants at exposure points, and the time period of exposure. These tend to simplify and approximate actual site conditions. In general, these assumptions are intended to be conservative and yield an overestimate of the true risk or hazard.

The toxicological database is also a source of uncertainty. The EPA has outlined some of the sources of uncertainty in the database (EPA 1986a,b, 1989a). These sources include extrapolation between exposure routes, from high to low doses, and from animals to humans; species, gender, age, and strain differences in uptake, metabolism, organ distribution, and target site susceptibility; and human population variability with respect to diet, environment, activity patterns, and cultural factors. The toxicity factors from IRIS and HEAST, which are used to estimate the toxicity of the COCs, are developed using a highly conservative methodology and probably tend to overestimate the potential hazards to humans.

Use of the provisional RfDs and SFs for DRPH, GRPH, and RRPH are an additional source of uncertainty in the toxicity assessment and risk characterization. Although the provisional RfDs represent the best available numerical estimate of toxicity, there is a significant amount of uncertainty associated with their use at the Oliktok Point installation. The RfDs and SFs are based on studies in mice and rats by the inhalation route of exposure; whereas, in this risk assessment, exposure of humans by the ingestion route only is being evaluated. Furthermore, in the absence of more thorough studies to compare the toxicity of DRPH, GRPH, and RRPH to the toxicity of known refinery streams, it is not clear how well the provisional values represent the toxicity of diesel, gasoline, and residual oils in humans.

In the risk characterization, the assumption was made that the total risk of developing cancer from exposure to site contaminants is the sum of the risk attributed to each individual contaminant. Likewise, the potential for the development of noncancer adverse effects is the sum of the HQs estimated for exposure to each individual contaminant. This approach does not account for the possibility that chemicals act synergistically or antagonistically but probably results in an overestimate of the true risk.

In addition to the more general sources of uncertainty associated with risk assessment methodology, there are site-specific sources of uncertainty. Primarily, these sources are associated with the lifestyle of the native northerners, the time spent on the sites that were investigated during the RI, and specific exposure assumptions (soil ingestion rate, exposure frequency, and exposure duration).

Similarly, no studies have been conducted to measure the soil ingestion rate of potential receptors on the contaminated sites. Soil ingestion by potential future inhabitants at Oliktok Point (assuming a potential residential scenario) may be greater than the default rate of 100 mg/day for adults and 200 mg/day for children. Given the rugged, partially subsistence, lifestyle of this group, it is possible that they incidentally ingest soil at a higher rate than receptors of a similar age in the continental United States. The estimate of soil ingestion rate used in this risk assessment may over- or underestimate the true rate.

The maximum exposure duration assumed for native northerners, 55 years, is probably fairly accurate. The reasonable maximum exposure (RME) estimate for inhabitants of the continental United States is 30 years, however, native northerners are more likely to remain in their villages for a longer period. Although, the exposure duration of 55 years is an estimate, it is not expected to significantly over- or underestimate hazard or risk.

2.6 RISK ASSESSMENT SUMMARY AND CONCLUSIONS

The human health risks associated with exposure contaminated media (soil, sediment, or surface water) at eight sites at the Oliktok Point radar installation were evaluated in this risk assessment. The risk assessment was developed using a three step process:

1) The maximum concentrations of the chemicals detected in each medium (soil, sediment, or surface water) were compared to background concentrations, RBSLs,

and ARARs. Chemicals present at concentrations that exceeded their background concentration and either an RBSL or ARAR were retained as COCs for the risk assessment.

2) In the risk characterization, the noncancer HQ, excess lifetime cancer risk, or both were calculated based on the maximum concentration of each COC and the associated toxicity values developed by EPA.

3) The HQs for each COC at a given site were summed, and the sum (called a Hazard Index) was compared to the regulatory benchmark for noncancer hazard: a hazard index of one. Sites where the hazard index exceeded one were considered to warrant either remediation or further discussion. Sites where the hazard index was less than one are considered to warrant no further action (EPA 1991d).

   The cancer risks for each carcinogenic COC at a given site were also summed and the sum (the total cancer risk) was compared to the regulatory benchmark for cancer risks: an excess lifetime cancer risk of 1×10^{-6} (one in one million). Sites where the total cancer risk exceeded 1×10^{-6} are considered to warrant either remediation or further discussion and investigation. Sites where the total cancer risk was less than 1×10^{-6} are considered to warrant no further action (EPA 1991d).

2.6.1 No Further Action

Sites that warrant no further action are those sites where the COCs are present at concentrations below those considered acceptable under EPA Region 10 guidance (EPA 1991a) or federal ARARs, or where the cumulative noncancer hazard and the excess lifetime cancer risk are less than 1.0 and 1×10^{-6}, respectively. Based on the human health risk assessment three of the eight sites at Oliktok Point require no further action. These sites include:

Dump Site (LF02). No COCs were identified (Table 2-1) based on the analysis of soil/sediment and surface water samples collected from this site. This does not indicate that exposure to chemicals in the soil, sediments, or surface water at the Dump Site is without health risk; however, the concentrations measured were less than the concentrations considered acceptable under Region 10 guidance (EPA 1991a) or federal ARARs.

POL Storage (ST04). No COCs were identified (Table 2-1) based on the analysis of soil or sediment and surface water samples collected from this site. This does not indicate that exposure to chemicals in the soil, sediments, or surface water at the POL Storage is without health risk; however, the concentrations measured were less than the concentrations considered acceptable under Region 10 guidance (EPA 1991a) or federal ARARs.

Diesel Spill (SS05). The cumulative noncancer hazard was less than 1.0 and the cumulative excess lifetime cancer risk was less than 1×10^{-6} (Table 2-10) based on exposure to the COCs in the soil/sediment and surface water at this site.

2.6.2 Sites that Warrant Further Discussion

Based on the noncancer hazard or excess lifetime cancer risk associated with the ingestion of soil/sediment and/or surface water, sites that warrant further discussion include:

Old Landfill (LF01). Based on the assumption that Aroclor 1254 is a carcinogenic member of the family of PCBs, the maximum concentration of Aroclor 1254 measured in the soil or sediment at this site yields a cancer risk of 1×10^{-5}. Although this cancer risk exceeds the 1×10^{-6} regulatory benchmark, it is still within the 1×10^{-6} to 1×10^{-4} cancer risk range that EPA considers to not warrant remediation under most circumstances (EPA 1991d). Such a policy would presumably apply at the Oliktok installation given the remote location, harsh climate, and the lack of receptors.

The maximum concentration of GRPH measured in the surface water at this site yields a cancer risk of 1×10^{-6}. Although this cancer risk meets the 1×10^{-6} regulatory benchmark, it is still within the 1×10^{-6} to 1×10^{-4} cancer risk range that EPA considers to not warrant remediation under most circumstances (EPA 1991d). Such a policy would presumably apply at the Oliktok installation given the remote location, harsh climate, and the lack of receptors.

Dock Storage Area (ST03). The maximum concentration of 1,2-dichloroethane measured in the surface water at this site yields a cancer risk of 2×10^{-6}. Although this cancer risk exceeds the 1×10^{-6} regulatory benchmark, it is still within the 1×10^{-6} to 1×10^{-4} cancer risk range that EPA considers to not warrant remediation under most circumstances (EPA 1991d). Such a policy would presumably apply at the Oliktok installation given the remote location, harsh climate, and the lack of receptors. Furthermore, 1,2-dichloroethane was detected in numerous background and blank samples collected during the 1993 RI and is assumed to be the result of field decontamination procedures. The hexane and methanol used in the decontamination procedures may have contained impurities including 1,2-dichloroethane.

Gasoline Storage Area (ST08). The maximum soil concentration of DRPH and, to a lesser extent, GRPH and RRPH, yield a noncancer hazard of 5 for the native northern adult/child receptor group. This value exceeds the regulatory benchmark of 1.0 (Table 2-10). Although the location and lack of receptors reduce the hazard associated with petroleum contamination of the soil, the relatively high concentrations of DRPH, GRPH, and RRPH would indicate that remediation of the soil at this site is reasonable.

The maximum concentrations of 1,2-dichloroethane and bis(2-ethylhexyl)phthalate measured in the surface water at this site yield a cancer risk of 2×10^{-6} for the DEW Line Worker and 8×10^{-6} for the native northern adult. Although these cancer risks slightly exceed the 1×10^{-6} regulatory benchmark, they are still within the 1×10^{-6} to 1×10^{-4} cancer risk range that EPA considers to not warrant remediation under most circumstances (EPA 1991d). Such a policy would presumably apply at the Oliktok installation given the remote location, harsh climate, and the lack of receptors. Furthermore, 1,2-dichloroethane was detected in numerous background and blank samples collected during the 1993 RI and is assumed to be the result of field decontamination procedures. The hexane and methanol used in the decontamination procedures may have contained impurities including 1,2-dichloroethane. Bis(2-ethylhexyl)phthalate is a common

laboratory contaminant and, given the relatively low concentrations observed, may not be representative of contamination due to installation activities.

Garage (SS10). The maximum soil concentration of DRPH and, to a lesser extent, GRPH and RRPH, yield a noncancer hazard of 2 for the native northern adult/child receptor group. This value exceeds the regulatory benchmark of 1.0 (Table 2-10). Although the location and lack of receptors reduce the hazard associated with petroleum contamination of the soil, the relatively high concentrations of DRPH, GRPH, and RRPH would indicate that remediation of the soil at this site is reasonable.

Aroclor 1254 (a member of the PCB family) was observed in one soil sample collected from the Garage. The concentration of Aroclor 1254 was relatively low and yielded a cancer risk of 5×10^{-6} for the native adult/child. Although this cancer risk exceeds the 1×10^{-6} regulatory benchmark, it is still within the 1×10^{-6} to 1×10^{-4} cancer risk range that EPA considers to not warrant remediation under most circumstances (EPA 1991d).

Old Sewage Area Petroleum Spill (SS11). The maximum surface water concentration of manganese yields a noncancer hazard of 8 for the DEW Line Worker and the native northern adult receptor groups. This value exceeds the regulatory benchmark of 1.0 (Table 2-10). Manganese is frequently found in surface and ground water impacted by contaminants and may be the result of processes that produce acidic conditions within site soils and water which result in the leaching of naturally-occurring manganese from the soil.

The maximum concentrations of GRPH and 1,2-dichloroethane measured in the surface water at this site yield a cancer risk of 1×10^{-6} for the DEW Line worker and 6×10^{-6} for the native northern adult. Although these cancer risks exceed the 1×10^{-6} regulatory benchmark, they are still within the 1×10^{-6} to 1×10^{-4} cancer risk range that EPA considers to not warrant remediation under most circumstances (EPA 1991d). Such a policy would presumably apply at the Oliktok installation given the remote location, harsh climate, and the lack of receptors. Furthermore, 1,2-dichloroethane was detected in numerous background and blank samples collected during the 1993 RI and is assumed to be the result of field decontamination procedures. The hexane and methanol used in the decontamination procedures may have contained impurities including 1,2-dichloroethane.

2.6.3 Summary of Human Health Risk Assessment

Table 2-11 contains a summary of the sites and associated risks that warrant further discussion based on excess cancer risk greater than 1×10^{-6} or the noncancer hazard greater than 1.0.

Highly conservative exposure assumptions were applied to the estimation of noncancer hazard and cancer risk, and the analytical samples, on which the estimates of hazard and risk are based, were collected from areas expected to be contaminated. Therefore, it is not likely under current conditions that any of the eight Oliktok Point sites pose a threat to human health.

TABLE 2-11. SUMMARY OF SITES AND MEDIA THAT WARRANT FURTHER DISCUSSION

SITE	MEDIUM	COMMENT
Old Landfill (LF01)	Soil/Sediment	Aroclor 1254 in soil/sediment yields a cancer risk of 1×10^{-5} for a native northern adult/child.
	Surface water	GRPH in surface water yields a cancer risk of 1×10^{-6} for the native northern adult.
Dock Storage Area (ST03)	Surface water	The cancer risk associated with 1,2-dichloroethane in surface water is 2×10^{-6} to the native adult.
Gasoline Storage Area (ST08)	Soil/Sediment	DRPH, GRPH, and RRPH in soil/sediment yields a noncancer hazard of 5 to the native northern adult/child.
	Surface water	1,2-Dichloroethane and bis(2-ethylhexyl)phthalate yield a cancer risk of 2×10^{-6} for the DEW Line worker, and 8×10^{-6} for a native northern adult.
Garage (SS10)	Soil/Sediment	DRPH, GRPH, and RRPH are the primary contaminants in soil/sediment that yield a noncancer hazard of 2 to the native northern adult/child. Aroclor 1254 is the primary contaminant that yields a cancer risk of 5×10^{-6} for the native adult/child.
Old Sewage Area Petroleum Spill (SS11)	Surface water	Manganese is the primary chemical in surface water that yields a noncancer hazard of 8 for the DEW Line worker and native northern adult. GRPH and 1,2-dichloroethane yields a cancer risk of 1×10^{-6} for the DEW Line worker, and 6×10^{-6} for the native northern adult.

Note: The noncancer hazards and excess lifetime cancer risks presented in this table are based on the maximum concentration of chemicals detected and potential future residential scenario. Under current site conditions, these potential exposure pathways are not complete and potential hazards and risks are minimal.

As noted in the exposure assessment section (Section 2.2), ingestion of soil/sediment and/or surface water at the Oliktok Point installation is only a potentially complete pathway if it is assumed that the installation will be deactivated and released for civilian use, and further if it is assumed that the limited surface water within the boundaries of the sites will be used as a potable supply. Such a scenario is highly unlikely. The installation currently receives its water supply from Prudhoe Bay/Deadhorse via truck. Should the installation be released for civilian use in the future, it is very likely that potable water would also be obtained from offsite. In conclusion, under current site conditions it does not appear that remediation of any site at the Oliktok Point installation is warranted on the basis of human health risk.

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3.0 ECOLOGICAL RISK ASSESSMENT

The objective of this ERA is to estimate potential impacts to aquatic and terrestrial plants and animals at the Oliktok Point DEW Line installation based on sampling and analyses conducted during the RI of the eight installation sites. The RI sampling was completed during the summer of 1993 in conjunction with sampling at seven other radar installations.

Guidance documents used during preparation of this assessment include:

- Handbook to Support the Installation Restoration Program Statements of Work (Air Force 1991);
- Framework for Ecological Risk Assessment (EPA 1992a); and
- Ecological Risk Assessment Guidance for Superfund (EPA 1994).

The approach used to assess potential ecological impacts is conceptually similar to that for human health risks. Potentially exposed populations (receptors) are identified, and information on exposure and toxicity are combined to derive estimates of risk. The ERA focuses, however, on potential impacts to populations of organisms rather than individual organisms (except in the case of endangered species where individuals are considered). Because ecosystems are composed of a variety of species, ERAs evaluate potential impacts to numerous species.

Ideally, ERAs should evaluate potential risks to communities and ecosystems, as well as to individual populations. Because of the large number of species and communities present in natural systems such ecosystem-wide assessments are very complex and appropriate assessment methodologies have not yet been developed. In addition, dose-response data on community or ecosystem responses generally are lacking. Therefore, evaluations of potential impacts to communities or ecosystems are qualitative.

The degree to which potential ecological impacts can be characterized is highly dependent upon the data available to support such estimates. Such data include: information regarding contaminant release, transport and fate; characteristics of potential receptor population; and adequate supporting toxicity data for the chemicals evaluated.

This ERA is intended to be at a screening level, rather than a full scale investigation of the state of the ecosystem. No site-specific studies of the biota were undertaken. It is based on media sampling (i.e., surface water and soil/sediment samples) and is divided into six sections:

Section 3.1 - Selection of Site Contaminants;
Section 3.2 - Exposure Assessment;
Section 3.3 - Ecological Toxicity Assessment;
Section 3.4 - Risk Characterization for Ecological Receptors;
Section 3.5 - Ecological Risk Assessment Uncertainty Analysis; and
Section 3.6 - Summary of Ecological Risk.

3.1 SELECTION OF SITE CONTAMINANTS

A stressor in the environment is a chemical, physical, or biological action that can cause a negative impact on an ecosystem (EPA 1992a). Only chemical stressors identified as COCs are evaluated as part of this ERA. A review of the site data indicates that the chemical stressors are primarily petroleum products, solvents, PCBs, and metals.

COCs are selected based on comparisons of the maximum detected concentrations to background concentrations and action levels [Federal Ambient Water Quality Criteria (AWQC); ADEC Water Quality Standards (18 AAC 70.020[b]) January 1995; Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota (Suter and Mabrey 1994); ADEC determination of cleanup levels for petroleum contaminated soils; EPA sediment quality criteria (as estimated by Hull and Suter, 1994); and NOAA Sediment Effects Range (Low) (NOAA 1991)]. If no action levels were available, the maximum detected concentration of the chemical was compared to a toxicity value derived from acute or chronic exposure tests available in the literature. If the maximum concentration was above this level, the compound was considered a COC. Chemicals present onsite at concentrations in excess of background concentrations and action levels were evaluated for frequency of detection in onsite media. If a chemical was detected at a frequency of less than five percent, it was not considered representative of actual site conditions and was eliminated from evaluation in the risk assessment. Further, an attempt was made to eliminate metals that were within the range of natural background levels. To that end, if the average concentration (exposure concentration) of a chemical was below the maximum background concentration or action level (i.e., if the average falls within the range of background or below a level of concern), and if the maximum detected concentration was less than twice the maximum background concentration (which is meant to approximate the 95 percent UCL of background concentrations), the chemical was not considered a COC. Note that this criterium is used to account for outliers (i.e., hotspots) that are not representative of the distribution and concentration of chemicals to which ecological receptors may be exposed. Tables 3-1 and 3-2 present the data used in the screening process for surface water and soil/sediment. Only chemicals that were detected in at least one environmental sample are presented in these summary tables.

In summary, the decisions for selecting COCs were made using the following logic:

STEP ONE: Is the chemical detected above the maximum detected background concentration?

No: Not considered a COC.
Yes: Continue to step two.

STEP TWO: Is the chemical detected above the action level or toxicity value?

No: Not considered a COC.
Yes: Continue to step three.

TABLE 3-1. SUMMARY OF CHEMICALS OF CONCERN: SURFACE WATER

CHEMICALS OF CONCERN: OLIKTOK POINT INSTALLATION SURFACE WATER						
CHEMICAL	RANGE OF DETECTED CONCENTRATIONS (µg/L)	BACKGROUND (µg/L) Organics = Oliktok Point Inorganics = seven arctic DEW Line installations	ACTION LEVEL (µg/L)	FREQUENCY OF DETECTION	AVERAGE CONCENTRATION FOR COC (µg/L)	SELECTED AS COC
ORGANICS						
DRPH	403 - 1,070	392 - 457	---	6/14	520	**YES**
GRPH	70 - 138	<20	---	2/14	33	**YES**
Toluene	2.9 - 24	<1	17,500[a]	2/14	2.4	NO
Ethylbenzene	3	<1	32,000[a]	1/14	0.68	NO
Xylenes (total)	6.7 - 31	<2	62,308[b]	2/14	3.6	NO
1,4-Dichlorobenzene	1.1	<1	763[c]	1/7	0.59	NO
1,2-Dichloroethane	1 - 1.9	<1	20,000[c]	3/7	0.84	NO
p-Isopropyltoluene	5.3	<1	---	1/7	1.2	NO
bis(2-Ethylhexyl)phthalate	48	<10	32.2	1/7	11.1	NO
Naphthalene	9.6	<1	620[b]	1/7	1.8	NO
1,2,4-Trimethylbenzene	31.5	<1	---	1/7	4.9	NO
1,3,5-Trimethylbenzene	12.5	<1	---	1/7	2.2	NO
INORGANICS - based on total metals (Section 3.1.1.2 discusses the rationale for not including one surface water sample.)						
Aluminum	180 - 300	<100 - 350	460[b]	3/5	170	NO
Barium	170 -290	<50 - 93	5,800[b]	5/5	230	NO
Calcium	67,000 - 100,000	4,500 - 88,000	116,000[b]	5/5	82,000	NO
Iron	920 - 3,100	180 - 2,800	1,000[c]	5/5	1,900	NO
Magnesium	26,000 - 85,000	<5,000 - 53,000	82,000[b]	5/5	46,000	NO
Manganese	62 - 360	<50 - 510	1,100[b]	5/5	190	NO
Potassium	13,000 - 20,000	<5,000	53,000[b]	2/5	8,100	NO
Sodium	95,000 - 590,000	8,400 - 410,000	680,000[b]	5/5	280,000	NO

TABLE 3-2. SUMMARY OF CHEMICALS OF CONCERN: SOILS AND SEDIMENTS

CHEMICALS OF CONCERN: OLIKTOK POINT INSTALLATION SOIL AND SEDIMENT						
CHEMICAL	RANGE OF DETECTED CONCENTRATIONS (mg/kg)	BACKGROUND RANGE (mg/kg)	ACTION LEVEL (mg/kg)	FREQUENCY OF DETECTION	AVERAGE CONCENTRATION FOR COC (mg/kg)	SELECTED AS COC
ORGANICS						
DRPH	5.7 - 300,000	13.8 - 167	500[b]	35/72	8,100	**YES**
GRPH	0.63 - 1,700	<0.6 - <1	100[b]	21/44	170	**YES**
RRPH	0.89 - 15,000	NA	2,000[b]	12/67	550	**YES**
Benzene	0.03 - 13	<0.03 - <0.06	0.052[c]	10/52	0.44	**YES**
Toluene	0.05 - 16	<0.03 - <0.06	0.786[c]	13/52	0.62	**YES**
Ethylbenzene	0.01 - 34	<0.03 - <0.06	4.36[c]	20/52	1.7	**YES**
Xylenes (total)	0.03 - 37	<0.06 - <0.12	1.21[c]	21/52	3.0	**YES**
Tetrachloroethene	0.04	<0.03 - <0.06	2.73[c]	1/10	0.01	NO
Trichloroethene	0.4	<0.03 - <0.06	1.07[c]	1/10	0.05	NO
n-Butylbenzene	0.08 - 6.6	<0.03 - <0.05	--	2/10	1.0	NO
sec-Butylbenzene	0.35 - 2.8	<0.03 - <0.05	4.36[f]	2/10	0.49	NO
Isopropylbenzene	0.53 - 1.9	<0.03 - <0.05	4.36[f]	2/10	0.39	NO
p-Isopropyltoluene	0.06 - 3	<0.03 - <0.05	--	3/10	0.51	NO
Naphthalene	0.5 - 8	<0.03 - <0.05	0.407[c]	3/10	1.53	NO
n-Propylbenzene	4.3	<0.03 - <0.05	--	1/10	0.67	NO

NA Not analyzed.
-- Not available.
a NOAA 1991, sediment ER-L (Effects Range - low).
b ADEC, Interim Guidance for Non-UST Contaminated Soil Cleanup Levels, 17 July 1991.
c EPA Sediment Quality Criteria (estimated using equilibrium partitioning approach in Hull and Suter 1994).
d NOAA 1991, Overall Apparent Effects Threshold.
e Washington State sediment criteria (Hull and Suter 1994).
f EPA Sediment Quality Criteria for Ethylbenzene (see text).

TABLE 3-2. SUMMARY OF CHEMICALS OF CONCERN: SOILS AND SEDIMENTS (CONTINUED)

CHEMICALS OF CONCERN: OLIKTOK POINT INSTALLATION SOIL AND SEDIMENT						
CHEMICAL	RANGE OF DETECTED CONCENTRATIONS (mg/kg)	BACKGROUND RANGE (mg/kg)	ACTION LEVEL (mg/kg)	FREQUENCY OF DETECTION	AVERAGE CONCENTRATION FOR COC (mg/kg)	SELECTED AS COC
1,2,4-Trimethylbenzene	0.1 - 27.4	<0.03 - <0.05	--	5/10	6.6	NO
1,3,5-Trimethylbenzene	0.23 - 24.7	<0.03 - <0.05	--	4/10	4.8	NO
Benzyl alcohol	2.5	<0.33 - <3.3	0.057[e]	1/9	0.91	**YES**
2-Methylnaphthalene	2.2	<0.33 - <3.3	--	1/9	0.83	NO
di-n-Butylphthalate	0.45-0.70	<0.33-<3.3	42.1	2/9	NA	NO
bis(2-Ethylhexyl) phthalate	0.45-0.47	<0.33-<3.3	890,000	2/9	NA	NO
PCBs (Aroclor 1254)	0.05 - 8.1	<0.03 - <0.1	0.17[c]	5/32	0.47	**YES**
INORGANICS						
Aluminum	1,400 - 7,300	1,500 - 25,000	--	8/8	3,300	NO
Barium	100 - 260	27 - 390	--	8/8	160	NO
Calcium	4,200 - 17,000	360 - 59,000	--	8/8	8,000	NO
Chromium	3.2 - 16	<4.3 - 47	81[a]	8/8	8.2	NO
Copper	8.1 - 17	<2.7 - 45	34[a]	7/8	12	NO
Iron	5,800 - 20,000	5,400 - 35,000	--	8/8	12,000	NO
Lead	12 - 69	<5.1 - 22	47[a]	4/8	18	**YES**

NA Not analyzed.
-- Not available.
a NOAA 1991, sediment ER-L (Effects Range - low).
b ADEC, Interim Guidance for Non-UST Contaminated Soil Cleanup Levels, 17 July 1991.
c EPA Sediment Quality Criteria (estimated using equilibrium partitioning approach in Hull and Suter 1994).
d NOAA 1991, Overall Apparent Effects Threshold.
e Washington State sediment criteria (Hull and Suter 1994).
f EPA Sediment Quality Criteria for Ethylbenzene (see text).

TABLE 3-2. SUMMARY OF CHEMICALS OF CONCERN: SOILS AND SEDIMENTS (CONTINUED)

CHEMICALS OF CONCERN: OLIKTOK POINT INSTALLATION SOIL AND SEDIMENT						
CHEMICAL	RANGE OF DETECTED CONCENTRATIONS (mg/kg)	BACKGROUND RANGE (mg/kg)	ACTION LEVEL (mg/kg)	FREQUENCY OF DETECTION	AVERAGE CONCENTRATION FOR COC (mg/kg)	SELECTED AS COC
Magnesium	580 - 3,000	360 - 7,400	--	8/8	12,000	NO
Manganese	73 - 1,000	25 - 290	--	8/8	290	**YES**
Nickel	5.2 - 14	4.2 - 46	21[a]	8/8	9.7	NO
Potassium	295 - 780	<300 - 2,200	--	4/8	330	NO
Sodium	130 - 1,000	<160 - 680	--	8/8	500	NO
Vanadium	6.9 - 17	6.3 - 59	--	8/8	11	NO
Zinc	20 - 110	9.2 - 95	150[a]	8/8	43	NO

NA Not analyzed.
-- Not available.
a NOAA 1991, sediment ER-L (Effects Range - low).
b ADEC, Interim Guidance for Non-UST Contaminated Soil Cleanup Levels, 17 July 1991.
c EPA Sediment Quality Criteria (estimated using equilibrium partitioning approach in Hull and Suter 1994).
d NOAA 1991, Overall Apparent Effects Threshold.
e Washington State sediment criteria (Hull and Suter 1994).
f EPA Sediment Quality Criteria for Ethylbenzene (see text).

STEP THREE: Is the chemical detected at a frequency greater than five percent?

No: Not considered a COC.
Yes: Continue to step four.

STEP FOUR: Is the average concentration of the chemical greater than the maximum background concentration, and is the maximum detected concentration greater than two times the maximum background concentration?

No: Not considered a COC.
Yes: Chemical is classified as a COC.

All data for COCs were averaged (arithmetic mean) according to media. In the case of non-detects, averages were calculated using one-half of the quantitation limits. Replicate samples were averaged and treated as one sample. Total metal concentrations were used in determining COCs in surface water. This is a conservative approach because dissolved metal concentrations (the more bioavailable fraction) can be significantly lower than total metal concentrations. Section 3.1.1 describes surface water COCs and Section 3.1.2 describes soil and sediment COCs; any exceptions to the selection methodology are discussed in these sections.

3.1.1 Surface Water

Analytical results from the Old Landfill (LF01), Dump Site (LF02), Dock Storage Area (ST03), Diesel Spill (SS05), Gasoline Storage Area (ST08), Garage (SS10), and Old Sewage Area Petroleum Spill (SS11) were compiled and evaluated to identify the COCs. Surface water samples were collected and analyzed for contaminants likely to be present at the specific sites. Not all samples were analyzed for a "full suite" of parameters, but instead were analyzed for some combination of the following: DRPH, GRPH, RRPH, BTEX, halogenated volatile organic compounds (HVOCs), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), PCBs, pesticides, and metals. A summary of analytical results for all sampling conducted at the installation is presented in Appendix G. The following sections present the evaluation of the surface water data. Table 3-1 summarizes the evaluation and selection of COCs in surface water.

3.1.1.1 Organic Compounds. The twelve organic compounds detected in surface water samples collected from the Oliktok Point installation were DRPH, GRPH, toluene, ethylbenzene, xylenes (total), 1,4-dichlorobenzene, 1,2-dichloroethane, bis(2-ethylhexyl)phthalate, p-isopropyltoluene, naphthalene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene. This section presents the evaluation of these compounds as COCs in surface water for the ERA.

DRPH were detected in 6 of 14 surface water samples at concentrations ranging from 403 to 1,070 µg/L. DRPH were detected in background samples at concentrations ranging from 392 to 457 µg/L. There is no established action level for DRPH. Because the detected concentrations exceeded background, DRPH were selected as a COC. The average concentration used in the evaluation of surface water was 520 µg/L.

GRPH were detected in 2 of 14 surface water samples at 70 and 138 µg/L. GRPH were not detected in background samples at a detection limit of 20 µg/L. There is no established action level for GRPH, but because these concentrations exceed the background levels, GRPH were selected as a COC. The average concentration of GRPH was 33 µg/L.

Toluene was detected in 2 of 14 surface water samples at concentrations of 2.9 and 24 µg/L. Toluene was not detected in background samples at a detection limit of 1 µg/L. Although the concentrations exceeded background levels, the detected concentration was well below the action level of 17,500 µg/L. As a result, toluene was not considered a COC.

Ethylbenzene was detected in 1 of 14 surface water samples at a concentration of 3 µg/L. Ethylbenzene was not detected in background samples at a detection limit of 1 µg/L. Although the concentration exceeded background levels, it was well below the action level of 32,000 µg/L. As a result, ethylbenzene was not considered a COC.

Xylenes (total) were detected in 2 of 14 surface water samples at concentrations of 6.7 and 31 µg/L. Xylenes were not detected in background samples at a detection limit of 2 µg/L. Although the concentrations exceeded background levels, the detected concentrations were well below the action level of 62,308 µg/L. As a result, xylenes were not considered a COC.

1,4-Dichlorobenzene was detected in one of seven surface water samples at a concentration of 1.1 µg/L. 1,4-Dichlorobenzene was not detected in background samples at a detection limit of 1 µg/L. The action level, based on EPA chronic AWQC, is 763 µg/L. Because the detected concentration did not exceed the action level, 1,4-dichlorobenzene was not selected as a COC.

1,2-Dichloroethane was detected in three of seven surface water samples at concentrations ranging from 1 to 1.9 µg/L. 1,2-Dichloroethane was not detected in background samples at a detection limit of 1 µg/L. Although the concentrations exceeded background levels, the detected concentration was well below the action level of 20,000 µg/L. As a result, 1,2-dichloroethane was not considered a COC.

bis(2-Ethylhexyl)phthalate was detected in one of seven surface water samples that were analyzed for SVOCs at a concentration of 48 µg/L. The action level for bis(2-ethylhexyl)phthalate is 32.2 µg/L (Hull and Suter 1994). Bis(2-ethylhexyl)phthalate is a common lab contaminant and only detected in one surface water sample. The installation-wide average concentration was well below the action level. Because bis(2-ethylhexyl)phthalate was only detected once and the fact that it is a common lab contaminant, bis(2-ethylhexyl)phthalate was not selected as a COC.

p-Isopropyltoluene was detected in one of seven surface water samples at a concentration of 5.3 µg/L. p-Isopropyltoluene was not detected in background samples at a detection limit of 1 µg/L. p-Isopropyltoluene is an alkylbenzene, a class of chemicals typically found in petroleum products (i.e., DRPH) (ATSDR 1993a). Because there are no action levels for p-isopropyltoluene and toxicity information is very limited, this chemical will be evaluated as one of the constituents of DRPH. DRPH were considered a COC (and detected at higher concentrations), so that the evaluation of the toxicity of DRPH will conservatively account for the incremental risk associated with low levels of alkylbenzenes.

Naphthalene was detected in one of seven surface water samples at a concentration of 9.6 μg/L. Naphthalene was not detected in background samples at a detection limit of 1 μg/L. Although the concentration exceeded background levels, it was below the action level of 620 μg/L. As a result, naphthalene was not considered a COC.

1,2,4-Trimethylbenzene was detected in one of seven surface water samples at a concentration of 31.5 μg/L. 1,2,4-Trimethylbenzene was not detected in background samples at a detection limit of 1 μg/L. 1,2,4-Trimethylbenzene is an alkylbenzene, a class of chemicals typically found in petroleum products (i.e., DRPH) (ATSDR 1993a). Because there are no action levels for 1,2,4-trimethylbenzene and toxicity information is very limited, this chemical will be evaluated as one of the constituents of DRPH. Because DRPH were considered a COC (and detected at higher concentrations), the evaluation of the toxicity of DRPH will conservatively account for the incremental risk associated with low levels of alkylbenzenes.

1,3,5-Trimethylbenzene was detected in one of seven surface water samples at a concentration of 12.5 μg/L. 1,3,5-Trimethylbenzene was not detected in background samples at a detection limit of 1 μg/L. 1,3,5-Trimethylbenzene is an alkylbenzene, a class of chemicals typically found in petroleum products (i.e., DRPH) (ATSDR 1993a). Because there are no action levels for 1,3,5-trimethylbenzene and toxicity information is very limited, this chemical will be evaluated as one of the constituents of DRPH. Because DRPH were considered a COC (and detected at higher concentrations), the evaluation of the toxicity of DRPH will conservatively account for the incremental risk associated with low levels of alkylbenzenes.

3.1.1.2 Metals. Six surface water samples collected were analyzed for metals at the Oliktok Point installation. The concentrations of total metals in duplicate sample SW03 and SW04 at the Old Sewage Area Petroleum Spill (SS11) were elevated for aluminum, barium, copper, iron, lead, vanadium, and zinc. However, the analysis for dissolved metals in this sample resulted in either non-detects (aluminum, copper, lead, vanadium, and zinc) or concentrations within "normal" limits (barium and iron). Total suspended solids (TSS) in the sample are over 100,000 times the maximum background level. Thus, the metals are likely to be bound to the suspended matter, because the dissolved analysis indicates low (i.e., non-detect or "normal") levels of metals. As a result, only five surface water samples are used to calculate the average concentrations to avoid inaccurately biasing the average surface water metal concentrations. Refer to Section 3.4, for discussions of the risk potentials for each group of receptors associated with metals at SW03 and SW04. The eight inorganic analytes detected in the five samples used to select inorganic COCs in surface water were aluminum, barium, calcium, iron, magnesium, manganese, potassium, and sodium. Analytes not detected in these surface water samples were antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc. This section presents the evaluation of the metals selected as COCs for the ERA. The background ranges presented are representative of seven arctic coast DEW Line installations. All concentrations of metals discussed below are results from total metal analyses.

It is important to note that, in some cases, sample quantitation limits for certain metals were somewhat higher than ecologically relevant action levels. For example, in the case of copper, the sample quantitation limit was 50 μg/L. However, the current AWQC (based on a hardness

value of 100 mg/L $CaCO_3$) for copper is 12 µg/L. As a result, an ecological risk may exist for aquatic organisms from exposure to certain metals at their sample quantitation limits. These metals include cadmium, chromium (VI), copper, lead, and selenium. These issues will be addressed further in Section 3.5, Uncertainty Analysis.

Aluminum was detected in three of five surface water samples at concentrations ranging from 180 to 300 µg/L. Background concentrations of aluminum ranged from <100 to 350 µg/L. The action level of 460 µg/L, based on data presented in Suter and Mabrey (1994), is the "Lowest Chronic Value for All Organisms". Aluminum was not selected as a COC because it did not exceed the maximum background level.

Barium was detected in all five surface water samples at concentrations ranging from 170 to 290 µg/L. Background concentrations of barium ranged from <50 to 93 µg/L. The action level for barium is 5,800 µg/L, based on data presented in Suter and Mabrey (1994). The value selected as the action level is the Lowest Chronic Value for All Organisms. Barium was not selected as a COC because it did not exceed the action level.

Calcium was detected in all five surface water samples at concentrations ranging from 67,000 to 100,000 µg/L. Background concentrations ranged from 4,500 to 88,000 µg/L. The action level is 116,000 µg/L based on the "Lowest Chronic Value for All Organisms" (Suter and Mabrey 1994). Calcium did not exceed the action level, thus it was not selected as a COC.

Iron was detected in all five surface water samples at concentrations ranging from 920 to 3,100 µg/L. Background concentrations ranged from 180 to 2,800 µg/L. The average concentration of 1,900 µg/L was below the maximum background level and the maximum concentration of 3,100 µg/L was not greater than twice the maximum background concentration. Thus, iron was not selected as a COC.

Magnesium was detected in all five surface water samples at concentrations ranging from 26,000 to 85,000 µg/L. Background concentrations ranged from <5,000 to 53,000 µg/L. A toxicological screening benchmark of 82,000 µg/L, based on the "Lowest Chronic Value for All Organisms" (Suter and Mabrey 1994) was used as an action level. Magnesium was not selected as a COC because the average concentration of 46,000 µg/L was below the maximum background concentration and the maximum detected concentration was less than twice the maximum background concentration.

Manganese was detected in all five surface water samples at concentrations ranging from 62 to 360 µg/L. Background analysis ranged from <50 to 510 µg/L. The action level for manganese is 1,100 µg/L based on the "Lowest Chronic Value for All Organisms" (Suter and Mabrey 1994). Manganese was not selected as a COC because it did not exceed the background level.

Potassium was detected in two of five surface water samples at concentrations of 13,000 and 20,000 µg/L. Potassium was not detected in background samples at a detection limit of 5,000 µg/L. Based on the "Lowest Chronic Value for All Organisms" (Suter and Mabrey 1994), 53,000 µg/L may be used as a toxicological screening benchmark. Potassium was not selected as a COC because it did not exceed the action level.

Sodium was detected in all five surface water samples at concentrations ranging from 95,000 to 590,000 µg/L. The background range for sodium was 8,400 to 410,000 µg/L. The action level for sodium of 680,000 µg/L was based on the "Lowest Chronic Value for All Organisms" (Suter and Mabrey 1994). Because concentrations did not exceed the action level, sodium was not selected as a COC.

3.1.2 Soils and Sediments

Soil/sediment sample analytical results from the eight sites were compiled and evaluated to determine the COCs. Because ecological receptors are principally exposed to surficial soils, only samples collected from 0 to 1.5 feet were considered in this ERA. Of the 86 soil/sediment samples collected, 75 are within this category. In addition, samples S02, S03, and S09-1.5 at the Garage (SS10) were not used in the analysis because they are beneath the Garage structure, where ecological receptors are unlikely to be exposed. Not all samples were analyzed for a "full suite" of parameters, but instead were analyzed for some combination of the following: DRPH, GRPH, RRPH, BTEX, HVOCs, VOCs, SVOCs, PCBs, pesticides, and metals. A summary of analytical results for all sampling conducted at the installation is presented in Appendix G. The following sections present the evaluation of the soil/sediment data for the eight sites. Only compounds that were detected on the sites are discussed. Table 3-2 summarizes the evaluation and selection of COCs in soil and sediment.

3.1.2.1 Petroleum Hydrocarbons. Soil/sediment samples were collected from the sites and selectively analyzed for DRPH, GRPH, and RRPH in 72, 44, and 67 samples, respectively. A discussion of these petroleum hydrocarbon mixtures and their toxicity is presented in Section 3.3.1.

DRPH were detected in 35 of 72 soil/sediment samples at concentrations ranging from 5.7 to 300,000 mg/kg. DRPH analyses in background samples ranged from 13.8 to 167 mg/kg. The action level for DRPH in soil/sediment is 500 mg/kg. Because DRPH were detected at concentrations above the action level, they were selected as COCs. The exposure concentration used in the risk assessment was the average concentration of 8,100 mg/kg.

GRPH were detected in 21 of 44 soil/sediment samples at concentrations ranging from 0.63 to 1,700 mg/kg. GRPH analyses in background samples resulted in non-detects at detection limits of 0.6 mg/kg to 1 mg/kg. The action level for GRPH is 100 mg/kg. GRPH were detected at concentrations above the action level, so they were considered COCs. GRPH in soil/sediment were evaluated in the risk assessment as components of DRPH. Refer to Section 3.3.1 for a discussion of the toxicity of petroleum hydrocarbon mixtures.

RRPH were detected in 12 of 67 soil/sediment samples at concentrations ranging from 0.89 to 15,000 mg/kg. The action level for RRPH is 2,000 mg/kg. RRPH were detected at concentrations above the action level, so they were considered COCs. RRPH in soil/sediment were evaluated in the risk assessment as components of DRPH. Refer to Section 3.3.1 for a discussion of the toxicity of petroleum hydrocarbon mixtures.

3.1.2.2 Benzene, Toluene, Ethylbenzene, and Xylenes. Fifty two soil/sediment samples were collected from the eight sites at the Oliktok Point installation and analyzed for BTEX using the 8020 or 8020 modified methods. Soil/sediment samples were also analyzed for BTEX using the VOC (8260) analysis. Because only 12 samples were analyzed using the 8260 method, the more comprehensive 8020 or 8020 modified method analysis was used to evaluate and select the COCs. Soil/sediment samples S01-0.5, S02-0.5, and S04-1.5 at the Gasoline Storage Area (ST08) were not included in the review of the BTEX data because the detection limits were very high due to high levels of DRPH and GRPH. The BTEX detection limits ranged from 7.9 to 44 mg/kg, and the use of one-half these values in the case of non-detects would have artificially inflated the average concentration of BTEX. This is a conservative approach that is expected to be protective of ecological receptors. The following paragraphs summarize the analytical results.

Benzene was detected in 10 of 52 soil/sediment samples at concentrations ranging from 0.03 to 13 mg/kg. Benzene was not detected in background samples at detection limits ranging from 0.03 to 0.06 mg/kg. The estimated action level for benzene is 0.052 mg/kg, based on the equilibrium partitioning approach presented in Hull and Suter (1994). Because benzene exceeded the background and action levels, it was selected as a COC. The average concentration used in the ERA was 0.44 mg/kg.

Toluene was detected in 13 of 52 soil/sediment samples at concentrations ranging from 0.05 to 16 mg/kg. Toluene analyses of background samples resulted in non-detects at detection limits of 0.03 mg/kg to 0.06 mg/kg. The estimated action level for toluene is 0.786 mg/kg, based on the equilibrium partitioning approach presented in Hull and Suter (1994). Because toluene detections exceeded the background and action levels, it was selected as a COC. The average concentration used in the ERA was 0.62 mg/kg.

Ethylbenzene was detected in 20 of 52 soil/sediment samples at concentrations ranging from 0.01 to 34 mg/kg. Ethylbenzene analyses in background samples resulted in non-detects at detection levels of 0.03 to 0.06 mg/kg. The action level is 4.36 mg/kg based on the equilibrium partitioning approach presented in Hull and Suter (1994). Because concentrations exceeded the background and action levels, ethylbenzene was selected as a COC. The average concentration used in the ERA was 1.7 mg/kg.

Xylenes (total) were detected in 21 of 52 soil/sediment samples. Xylene concentrations ranged from 0.03 to 37 mg/kg. Xylene analyses in background samples resulted in non-detects at detection limits of 0.06 to 0.12 mg/kg. The action level is 1.21 mg/kg. Xylenes were considered a COC because concentrations were above background and action levels. The average concentration used in the ERA was 3.0 mg/kg.

3.1.2.3 Volatile Organic Compounds. A total of ten VOCs were detected in soil/sediment samples using either the HVOC (8010) or VOC (8260) method of analysis. The compounds detected were tetrachloroethene, trichloroethene, n-butylbenzene, sec-butylbenzene, isopropylbenzene, p-isopropyltoluene, naphthalene, n-propylbenzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene. Because incorporating non-detects (using one-half the detection limit) with unusually high quantitation limits skews the average (artificially inflating the average above the maximum detected concentrations), samples with detection limits that were more than twice

the maximum detection were not considered in the COC analysis. This section presents the evaluation of these compounds as COCs.

Tetrachloroethene was detected in 1 of 10 soil/sediment samples at a concentration of 0.04 mg/kg. Tetrachloroethene analyses in background samples yielded non-detects at detection limits of 0.03 to 0.06 mg/kg. The action level is 2.73 mg/kg based on the equilibrium partitioning approach presented in Hull and Suter (1994). Because the concentration did not exceed the action level, tetrachloroethene was not selected as a COC.

Trichloroethene was detected in 1 of 10 soil/sediment samples at a concentration of 0.4 mg/kg. Trichloroethene analyses in background samples yielded non-detects at detection limits of 0.03 to 0.06 mg/kg. The action level is 1.07 mg/kg based on the equilibrium partitioning approach presented in Hull and Suter (1994). Because the concentration did not exceed the action level, trichloroethene was not selected as a COC.

n-Butylbenzene was detected in 2 of 10 soil/sediment samples at concentrations of 0.08 and 6.6 mg/kg. n-Butylbenzene analyses in background samples yielded non-detects at detection limits of 0.03 to 0.05 mg/kg. No action level is available. n-Butylbenzene is an alkylbenzene, a typical constituent of fuel oil (i.e., DRPH) (ATSDR 1993a). As a result, n-butylbenzene was not selected as a COC because the evaluation of the toxicity of DRPH (evaluated at a concentration of 8,100 mg/kg) will conservatively account for the incremental risk associated with n-butylbenzene.

sec-Butylbenzene was detected in 2 of 10 soil/sediment samples analyzed for VOCs. The detected concentrations were 0.35 and 2.8 mg/kg. The maximum background concentration of sec-butylbenzene is <0.05 mg/kg. There are no action levels for this compound, so the action level of 4.36 mg/kg for a similar compound, ethylbenzene, was used. Onsite concentrations do not exceed the action level, so it is not considered a COC.

Isopropylbenzene was detected in 2 of 10 soil/sediment samples at concentrations of 0.53 and 1.9 mg/kg. The maximum background concentration is <0.05 mg/kg. There are no action levels for this compound. Isopropylbenzene is an alkyl-substituted benzene, and the action level of 4.36 mg/kg for a similar compound, ethylbenzene, was used. This compound was detected below the action level, so it is not considered a COC.

p-Isopropyltoluene was detected in 3 of 10 soil/sediment samples at concentrations ranging from 0.06 to 3 mg/kg. p-Isopropyltoluene analyses in background samples yielded non-detects at <0.03 to <0.05 mg/kg. No action level is available. p-Isopropyltoluene is an alkylbenzene, a typical constituent of fuel oil (i.e., DRPH) (ATSDR 1993a). As a result, p-isopropyltoluene was not selected as a COC because the evaluation of the toxicity of DRPH (evaluated at a concentration of 8,100 mg/kg) will conservatively account for the incremental risk associated with p-isopropyltoluene.

Naphthalene was detected in 3 of 10 soil/sediment samples at concentrations ranging from 0.5 to 8 mg/kg. Naphthalenes are constituents of fuel oils (ATSDR 1993a). As a result, naphthalene was not selected as a COC because the evaluation of the toxicity of DRPH (evaluated at a

concentration of 8,100 mg/kg) will conservatively account for the incremental risk associated with naphthalene.

n-Propylbenzene was detected in 1 of 10 soil/sediment samples at a concentration of 4.3 mg/kg. Background level concentrations of n-propylbenzene were not detected at detection limits ranging from 0.03 to 0.05 mg/kg. n-Propylbenzene is an alkylbenzene, a class of chemicals typically found in fuel oils (i.e., DRPH) (ATSDR 1993a). Because there are no action levels for n-propylbenzene and toxicity information is very limited, this chemical will be evaluated as one of the constituents of DRPH. Because DRPH is considered a COC (and detected at higher concentrations), the evaluation of the toxicity of DRPH will conservatively account for the incremental risk associated with low levels of alkylbenzenes.

1,2,4-Trimethylbenzene was detected in 5 of 10 soil/sediment samples at concentrations ranging from 0.1 to 27.4 mg/kg. It was not detected in background samples at detection limits from 0.03 to 0.05 mg/kg. 1,2,4-Trimethylbenzene is an alkylbenzene, which is a typical constituent of fuel oil (i.e., DRPH) (ATSDR 1993a). As a result, 1,2,4-trimethylbenzene was not selected as a COC because the evaluation of the toxicity of DRPH (evaluated at a concentration of 8.100 mg/kg) will conservatively account for the incremental risk associated with 1,2,4-trimethylbenzene.

1,3,5-Trimethylbenzene was detected in 4 of 10 soil/sediment samples at concentrations of 0.23 to 24.7 mg/kg. It was not detected in background samples at detection limits from 0.03 to 0.05 mg/kg. 1,3,5-Trimethylbenzene is an alkylbenzene, a typical constituent of fuel oil (i.e., DRPH) (ATSDR 1993a). As a result, 1,3,5-trimethylbenzene was not selected as a COC because the evaluation of the toxicity of DRPH (evaluated at a concentration of 8,100 mg/kg) will conservatively account for the incremental risk associated with 1,3,5-trimethylbenzene.

3.1.2.4 Semivolatile Organic Compounds. Four semivolatile organic compounds were detected at the Oliktok Point installation (in addition to naphthalene, which is discussed above) using the 8270 method of analysis: benzyl alcohol, di-n-butylphthalate, bis(2-ethylhexyl)phthalate, and 2-methylnaphthalene. These chemicals were not detected in background samples at detection limits ranging from 0.33 to 3.3 mg/kg.

Benzyl alcohol was detected in one of nine soil/sediment samples at a concentration of 2.5 mg/kg. The action level for this compound is 0.057 mg/kg, based on the Washington State sediment standard presented in Hull and Suter (1994). Because the benzyl alcohol concentrations were above the action level, this compound was selected as a COC. The average concentration used in the ERA was 0.91 mg/kg.

di-n-Butylphthalate was detected in two of nine soil/sediment samples that were analyzed for SVOCs at concentrations of 0.45 and 0.70 mg/kg. The action level for di-n-butylphthalate is 42.1 mg/kg (Hull and Suter 1994). Because the detected concentrations did not exceed the action level, di-n-butylphthalate was not selected as a COC.

bis(2-Ethylhexyl)phthalate was detected in two of nine soil/sediment samples that were analyzed for SVOCs at concentrations of 0.45 and 0.47 mg/kg. The action level for bis(2-

ethylhexyl)phthalate is 890,000 mg/kg (Hull and Suter 1994). Because the detected concentration did not exceed the action level, bis(2-ethylhexyl)phthalate was not selected as a COC.

2-Methylnaphthalene was detected in one of nine soil/sediment samples at a concentration of 2.2 mg/kg. There are no action levels available for this compound. Naphthalenes are constituents of fuel oils (ATSDR 1993a). As a result, the evaluation of the toxicity of DRPH (evaluated at a concentration of 8,100 mg/kg) will conservatively account for the incremental risk associated with 2-methylnapthalene.

3.1.2.5 Polychlorinated Biphenyls (PCBs). Aroclor 1254 was detected in 5 of 32 soil/sediment samples at concentrations ranging from 0.05 to 8.1 mg/kg. Aroclor 1254 was not detected in background samples at detection limits of 0.03 to 0.1 mg/kg. The action level for Aroclor 1254 is 0.17 mg/kg. Because the detected concentrations exceed this level, Aroclor 1254 was selected as a COC. The average concentration used in the ERA was 0.47 mg/kg.

3.1.2.6 Metals. Fourteen inorganic analytes were detected in eight soil/sediment samples collected and analyzed for metals from the Oliktok Point installation. The metals detected were aluminum, barium, calcium, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc. This section presents the evaluation of these metals as COCs in the ERA.

Aluminum was detected in all eight soil/sediment samples. Concentrations ranged from 1,400 to 7,300 mg/kg. Background concentrations ranged from 1,500 to 25,000 mg/kg. Because aluminum concentrations did not exceed background concentrations, aluminum was not selected as a COC.

Barium was detected in all eight soil/sediment samples at concentrations ranging from 100 to 260 mg/kg. The background concentrations of barium ranged from 27 to 390 mg/kg. There is no action level for barium. Because barium concentrations did not exceed background concentrations, barium was not selected as a COC.

Calcium was detected in all eight soil/sediment samples analyzed for metals at concentrations ranging from 4,200 to 17,000 mg/kg. Background concentrations ranged from 360 to 59,000 mg/kg. There is no action level for calcium. Because concentrations did not exceed background concentrations, calcium was not selected as a COC.

Chromium was detected in all eight soil/sediment samples analyzed for metals at concentrations ranging from 3.2 to 16 mg/kg. The maximum background concentration was 47 mg/kg. The action level for chromium is 81 mg/kg. Because the detected concentrations did not exceed the maximum background level, chromium was not selected as a COC.

Copper was detected in seven of eight soil/sediment samples analyzed for metals at concentrations ranging from 8.1 to 17 mg/kg. Background concentrations ranged from <2.7 to 45 mg/kg. The action level for copper is 34 mg/kg. Because the detected concentrations did not exceed the maximum background concentration, copper was not selected as a COC.

Iron was detected in all eight soil/sediment samples analyzed for metals at concentrations ranging from 5,800 to 20,000 mg/kg. The background concentrations ranged from 5,400 to 35,000 mg/kg. The detected concentrations did not exceed the maximum background concentration, so iron was not selected as a COC.

Lead was detected in four out of eight soil/sediment samples analyzed for metals at concentrations ranging from 12 to 69 mg/kg. Background concentrations ranged from <5.1 to 22 mg/kg. The action level for lead is 47 mg/kg. The average detected concentration of lead (18 mg/kg) was below the maximum background level (22 mg/kg), but the maximum detected concentration (69 mg/kg) was greater than twice the maximum background level (44 mg/kg). As a result, lead was selected as a COC. The average concentration of 18 mg/kg was used as the exposure point concentration.

Magnesium was detected in all eight soil/sediment samples analyzed for metals at concentrations ranging from 580 to 3,000 mg/kg. The background concentrations for magnesium ranged from 360 to 7,400 mg/kg. There is no action level for magnesium. Because concentrations did not exceed background concentrations, it was not selected as a COC.

Manganese was detected in all eight soil/sediment samples. Concentrations ranged from 73 to 1,000 mg/kg. The background concentrations for manganese ranged from 25 to 290 mg/kg. There are no action levels for manganese. Because onsite concentrations exceeded background concentrations, this chemical was selected as a COC. The average concentration that was evaluated in the risk assessment was 290 mg/kg.

Nickel was detected in all eight soil/sediment samples analyzed for metals at concentrations ranging from 5.2 to 14 mg/kg. The background concentrations ranged from 4.2 to 46 mg/kg. The action level for nickel is 21 mg/kg. Nickel was not selected as a COC because its concentrations did not exceed the maximum background level.

Potassium was detected in four of eight soil/sediment samples analyzed for metals at concentrations ranging from 295 to 780 mg/kg. The background concentrations ranged from <300 to 2,200 mg/kg. There is no action level for potassium. Potassium was not selected as a COC because its concentrations were below the maximum background concentration.

Sodium was detected in all eight soil/sediment samples analyzed for metals at concentrations ranging from 130 to 1,000 mg/kg. These concentrations exceed the maximum background concentration of 680 mg/kg. There is no action level for sodium. This metal was not retained as a COC because sodium was detected only twice above background and the sample did not significantly exceed the background concentration. In addition, sodium is ubiquitous in the environment and is not expected to pose a threat to ecological receptors.

Vanadium was detected in all eight soil/sediment samples analyzed for metals at concentrations ranging from 6.9 to 17 mg/kg. The background concentrations ranged from 6.3 to 59 mg/kg. There is no action level for vanadium. Vanadium was not selected as a COC because its concentrations were below the maximum background concentration.

Zinc was detected in all eight soil/sediment samples analyzed for metals at concentrations ranging from 20 to 110 mg/kg. The background concentrations for zinc ranged from 9.2 to 95 mg/kg. The action level for zinc is 150 mg/kg. Zinc was not selected as a COC because its concentrations were below the action level.

In summary, the COCs for surface water are DRPH and GRPH. The COCs for soil/sediment are DRPH, GRPH, RRPH, benzene, toluene, ethylbenzene, xylenes (total), benzyl alcohol, PCBs, lead, and manganese.

3.2 ECOLOGICAL EXPOSURE ASSESSMENT

The vegetation of the Arctic Coastal Plain and the ecosystems it characterizes have developed primarily as a result of the low relief and harsh environment. The growing season is short, typically extending from June through mid-September. Winters are long, cold, dry, and dark. Air temperatures that average below freezing for most of the year result in a permafrost layer that begins near the ground surface and reaches to depths as great as 610 meters. Seasonal thawing results in an active layer between ground surface and 3.7 meters below the surface (Hart Crowser 1987).

The impervious permafrost layer prevents percolation and infiltration of water below the active layer, and the generally flat terrain provides poor drainage. As a result, the ecosystems of the Arctic Coastal Plain are often defined not only by their plant associations but also by the degree of water found in and on them. Hart Crowser (1987) describes five major ecosystems for the classification of tundra and Arctic Coastal Plain communities:

- Marine zones: these include lagoons, estuaries, barrier islands, strands, and beaches. The abundance of vegetation along the marine coastal zone is inversely related to the amount of beach scouring by waves and ice. Mainland beaches support a variety of vegetation including sedges, grasses, and forbs.

- Wet sedge meadows: an association of meadows, ponds, and lakes also known as "wet tundra". This system, with its associated wetlands, is dominant in the area extending west from the Colville River to the Chukchi Sea (including the Point Lonely, Point Barrow, Wainwright, Point Lay, and Cape Lisburne installations). Differences in vegetation within this ecosystem are related to moisture and microrelief.

- Tussock tundra: "moist tundra" consisting primarily of areas dominated by tussock-forming cottongrass. This system covers significant portions of the Arctic Coastal Plain.

- Riverine systems and floodplains: including riparian shrubland on recent and old alluvium. Being better drained than surrounding lands, the riparian environment supports a distinctive "shrub thicket" vegetation.

- Alpine tundra: including rocky upland areas of sparse mat-forming or fell-field vegetation.

The species associated with each ecosystem at the Oliktok Point DEW Line installation have the potential to be exposed to COCs if exposure pathways are complete. If pathways are complete, the representative species selected are considered receptors. Figure 3-1, Section 3.2.3, presents a schematic model of the potential exposure pathways.

The Ecological Exposure Assessment segment of the risk assessment contains information on the following topics: the most common species found at the DEW Line installations in Section 3.2.1, species of the Arctic Coastal Plain; the representative species and the rationale used for their selection in Section 3.2.2; a discussion of the exposure pathways in Section 3.2.3; and a review of the habitat suitability for representative species in Section 3.2.4. Sections 3.2.5, 3.2.6, and 3.2.7 provide the methodology of the exposure assessment for representative plants, aquatic species, and birds and mammals, respectively. Life history tables, which provide species-specific information for use in the exposure assessment, are included in Section 3.2.7.

3.2.1 Species of the Arctic Coastal Plain

The representative species used in the ERA for the Oliktok Point installation were selected from species characteristic of the DEW Line installations along the Arctic Coastal Plain and are detailed in Sections 3.2.2.1 through 3.2.2.5.

The Oliktok Point installation is located along the northern boundary of the Arctic Coastal Plain. Hart Crowser (1987) and Woodward-Clyde (1993) have listed the species likely to occur along the coastal plain based on site-specific studies and a review of the literature. The marine zone, wet sedge meadows, tussock tundra, and riverine/riparian are the primary ecosystems found at the Oliktok Point installation. Alpine tundra is minimal at the site and is not evaluated further. Site-specific surveys of the ecosystems associated with the DEW Line installations have not been conducted for this risk assessment; however, a study investigating the abundance and distribution of Steller's and spectacled eiders was used (Alaska Biological Research 1994).

3.2.1.1 Plants. Plants commonly associated with the marine zone are sedges, grasses, and forbs. *Carex subspathacea* and *C. aquatilis* are dominant plants in the coastal wetlands.

The wet sedge meadow (also known as "wet tundra") is characterized by a variety of sedges and grasses. Typical species include cottongrass, *Eriophorum* spp.; tundra grass, *Dupontia fischeri*; and mosses, *Sphagnum* spp. Marsh marigold, *Caltha palustris*; and horsetail, *Equisetum* spp. may be found in wetter areas (Hart Crowser 1987).

The tussock tundra (or moist tundra) is drier than the wet sedge meadow/wet tundra association. Tussock-forming cottongrass is the dominant plant species. Grasses, sedges, dwarf shrubs, mosses, and lichens are scattered throughout the tussock complex. These species include willows, *Salix* spp.; Labrador tea, *Ledum palustri*; blueberry and lingonberry, *Vaccinium* spp.; and lousewort, *Pedicularis* spp. (NPRA Task Force 1978; Bergman et al. 1977).

Riverine/riparian systems are composed of a diversity of habitat types and species. The dominant plants here are shrubs with a scattered understory of grasses, herbs, and lower growing shrubs. Larkspur, *Delphinum brachycentrum*; cinquefoil, *Potentilla* spp.; bearberry, *Arctostaphylos* spp.; and wormword, *Artemesia arctica*, are common species (NPRA Task Force 1978; Bergman et al. 1977).

3.2.1.2 Aquatic Organisms. Sixty-six species of fish inhabiting marine, estuarine, and freshwater systems have been identified in the arctic region (Hart Crowser 1987). Marine species inhabiting the nearshore and offshore waters include boreal smelt, *Osmerus eperlanus*; Pacific herring, *Clupea harengus*; arctic cod, *Boreogagus saida*; and fourhorn sculpin, *Myoxocephalus quadricornis*. Anadromous species using arctic rivers for spawning include the arctic cisco, *Coregonus autumnalis*; arctic char, *Salvelinus alpinus*; and occasional pink and chum salmon, *Oncorhynchus* spp. Lack of overwintering habitat is a significant limiting condition for both anadromous and freshwater fish of the arctic region. The principal freshwater fish found in the region are grayling, *Thymallus arcticus*; lake trout, *Salvelinus namaycush*; burbot, *Lota lota*; and nine-spined stickleback, *Pungitius pungitius* (Hart Crowser 1987).

Invertebrates that may be present in the waters and wet habitats of the Arctic Coastal Plain are well represented by the crustaceans (i.e., copepods, isopods, amphipods, and decapods).

3.2.1.3 Birds. There are approximately 180 species of birds seasonally associated with the habitats of the Arctic Coastal Plain. Of these, many are shorebirds and waterfowl using migratory corridors that pass through the Oliktok Point area. Bird use of the coastal plain is highly seasonal and associated with typical avian breeding and migration cycles. Shoreline habitats are used significantly in association with molting, pre-migratory staging, and post breeding movement. These habitats are considered critical by the U.S. Fish and Wildlife Service (USFWS 1982). Principal species include glaucous gull, *Larus hyperboreus*; red phalarope, *Phalaropus fulicaria*; dunlin, *Calidris alpina*; loons, *Gavia* spp.; sandpipers, *Calidris* spp.; eiders, *Somateria* spp.; and geese, *Branta* spp. and *Chen* sp. Among the migratory passerine species using the coastal habitats are the Savannah sparrow, *Passerculus sandwichensis*; common and hoary redpolls, *Carduelis* spp.; snow bunting, *Plectrophenax nivalis*; and Lapland longspur, *Calcarius lapponicus* (Woodward-Clyde 1993).

3.2.1.4 Mammals. The mammalian fauna of the Arctic Coastal Plain and adjacent waters is relatively simple compared to fauna at lower latitudes. A review of species lists indicates a total of 38 species that commonly occur in the arctic; 11 of these are marine mammals (Hart Crowser 1987). A sampling of the terrestrial mammals geographically associated with the DEW Line stations, including Oliktok Point, consists of: brown lemming, *Lemmus trimucronatus*; masked shrew, *Sorex cinereus*; arctic fox, *Alopex lagopus*; red fox, *Vulpes vulpes*; weasels, *Mustela* spp.; tundra vole, *Microtus oeconomus*; caribou, *Rangifer tarandus*; and grizzly bear, *Ursus arctos* (Hart Crowser 1987; Woodward-Clyde 1993).

Marine mammals of the arctic coast include polar bear, *Ursus maritimus*; walrus, *Odobenus rosmarus;* six species of whales; and five species of seals. The most common of the whale and seal species are beluga, *Delphinapterus leucas*; bowhead whale, *Balaena mysticetus*; gray whale,

Eschrichtius robustus; ringed seal, *Phoca hispida*; and bearded seal, *Erignathus barbatus* (Hensel et al. 1984).

3.2.1.5 Threatened and Endangered Species. Species of the Arctic Coastal Plain and nearby waters that are protected by federal and state designations include bowhead whale (endangered); fin whale, *Balaenoptera physalus* (endangered); sei whale, *Balaenoptera borealis* (endangered); and humpback whale, *Megaptera novaengliae* (endangered). The gray whale was delisted by the National Marine Fisheries Service on 16 June 1994. Avian species include the spectacled eider, *Somateria fischeri* (threatened) and Steller's eider, *Polysticta stelleri* (candidate for listing). Based on the latest federal and state lists of threatened and endangered plant species (June 1995), no plant species at the DEW Line installations are currently listed as threatened or endangered.

3.2.2 Representative Species

It is impractical to evaluate all of these potential receptors individually because of the great diversity of plants and animals at a given site. Thus, for ERAs, a set of "representative species" is selected for further evaluation. The representative species are selected based primarily on the species' likelihood of exposure given their preferred habitat. feeding habits, and distribution of contaminants. Potential exposure pathways are shown in Figure 3-1 and discussed in Section 3.2.3. The abundance of a species relative to the areal extent of the sites is also considered. The representative species encompass a range of ecological niches in order to achieve the best characterization of the ecosystems being examined. In addition, species are selected, in part, as a result of the availability of toxicity, exposure, and life history information. Species that may be sensitive to environmental impacts, such as endangered or threatened species, are also evaluated. Any endangered or threatened species that are discussed in the ERA are not considered representative of the Arctic Coastal Plain or the Air Force arctic radar installations. These species are evaluated to provide information about whether they face potential risks from exposure to the COCs being evaluated in the ERA.

For the DEW Line stations, the groups of receptors evaluated include plants, aquatic invertebrates, fishes, birds, and mammals. Potential risks to representative species are estimated by evaluating sampling data for the relevant exposure media (i.e., soil, sediments, and surface water). For plants, soil/sediment COC data are used to estimate potential uptake. For aquatic species, surface water COC concentrations are used to estimate exposure, and for birds and mammals, exposures are estimated by evaluating their potential dietary intakes of COCs. No site-specific studies were conducted to determine exposure or toxicity levels at the installation.

The similarity of ecosystems at each of the arctic coastal DEW Line installations allows the use of the same set of representative species for all installations. It may be possible that a representative species inhabits the general area of an installation, but does not occur specifically on the installation property. When and if this situation occurs, it will be noted. The receptors selected as representative species for the Oliktok Point installation are listed in the paragraphs that discuss the representative groups (i.e., plants, aquatic organisms, birds, mammals, and threatened or endangered species). Table 3-3 presents the representative and sensitive species for arctic coastal DEW Line installations, including endangered and threatened species that

potentially may be exposed. The USFWS was consulted about the occurrence and selection of threatened and endangered species.

3.2.2.1 Representative Plants. Plants selected as representative species are sedges, willows, cottongrass, and various berry-bearing plants, *Vaccinium* spp. These species were selected because they are abundant on all the sites, are important links in the trophic structure of the ecosystems of the arctic, and represent a major percentage of the primary production along the coastal plain. The blueberry, huckleberry, and lingonberry, *Vaccinium* spp., are also evaluated because of their roles as forage plants and as subsistence species. All of these representative species are evaluated at the Oliktok Point installation.

3.2.2.2 Representative Aquatic Invertebrates and Fish. The invertebrates selected as representative species are *Daphnia* spp. (water fleas). The nine-spined stickleback is the representative fish species. The arctic char is not evaluated at the Oliktok Point installation because it is unlikely that the exposure pathways are complete. *Daphnia* spp. are abundant and represent a portion of the diet of the selected fish species (Johnson and Burns 1984; Wootton 1976), and toxicity information is readily available for them. The nine-spined stickleback is a freshwater species that also uses brackish habitats, nests in aquatic vegetation, and is prey for other fish and bird species (Wootton 1976). No marine mammals are evaluated in the Oliktok Point ERA because there are no complete pathways for COCs (at concentrations that are of concern) to reach potential marine receptors.

3.2.2.3 Representative Birds. The representative avian species are Lapland longspur; brant, *Branta bernicla*; glaucous gull; and pectoral sandpiper, *Calidris melanotos*. The Lapland longspur is a passerine belonging to a terrestrial feeding guild (including sandpipers, turnstones, and phalaropes) (Custer and Pitelka 1978). The longspur's diet of insects and seeds (Custer and Pitelka 1978) makes it an important link in the arctic trophic web. The brant nests and molts among the numerous ponds in the tussock tundra and grazes on sedges and cottongrass (Palmer 1976). It is considered to be an important subsistence resource. The glaucous gull is a predatory scavenger that feeds on small mammals, young birds, carrion, and garbage, and breeds along the Arctic Coastal Plain (Farrand 1983). The pectoral sandpiper is an abundant shorebird that is primarily insectivorous and breeds on the Arctic Coastal Plain. The Lapland longspur, brant, glaucous gull, and pectoral sandpiper are in potential exposure pathways at the Oliktok Point installation and are evaluated in this ERA. All the avian species in this ERA are migratory, and as such, are protected under the Migratory Bird Treaty Act of 1978. This is reflected by the use of a protected species factor of 2 in the calculation of avian toxicity reference values.

3.2.2.4 Representative Mammals. The representative species of mammals are the brown lemming, arctic fox, and barren-ground caribou. The brown lemming is the predominant small mammal at all the coastal arctic DEW Line installations. The lemming consumes more vegetation than expected for an animal its size, due to its low assimilation efficiency, the low nutrient value of winter forage, and the high metabolic demands of the arctic environment

TABLE 3-3. REPRESENTATIVE AND SENSITIVE SPECIES AT THE DEW LINE INSTALLATIONS[a]

COMMON NAME	GENUS AND SPECIES
PLANTS	
Sedge	*Carex* spp.
Cottongrass	*Eriophorum* spp.
Willow	*Salix* spp.
Berries	*Vaccinium* spp.
AQUATIC ORGANISMS	
Water fleas	*Daphnia* spp.
Nine-spined stickleback	*Pungitius pungitius*
Arctic char	*Salvelinus alpinus*
BIRDS	
Lapland longspur	*Calcarius lapponicus*
Brant	*Branta bernicla*
Glaucous gull	*Larus hyperboreus*
Pectoral sandpiper	*Calidris melanotos*
MAMMALS	
Brown lemming	*Lemmus trimucronatus*
Arctic fox	*Alopex lagopus*
Barren-ground caribou	*Rangifer tarandus*
ENDANGERED AND THREATENED SPECIES	
Spectacled eider[b]	*Somateria fischeri*
Steller's eider[c]	*Polysticta stelleri*

a These representative species were selected for seven Dew Line installations (Barter Island, Bullen Point, Oliktok Point, Point Lonely, Point Barrow, Wainwright, and Point Lay) and the Cape Lisburne radar installation.
b Threatened status.
c Candidate for threatened status, see text for explanation.

(Chappell 1980). The arctic fox is selected as a representative species because it is ubiquitous along the coastal plain, and its carnivorous diet (mostly lemmings) places it near the top of the trophic structure in the arctic. Eberhardt et al. (1982) note that in fall and winter, and to a lesser extent in summer, the arctic fox frequently uses areas near development. This tendency may expose the fox to pathways of contamination. Additionally, the fox, a relatively common furbearer, can be an important subsistence resource. The caribou is selected as a representative species because it uses areas on, or near, a number of the radar installations during migration, calving, and post-calving. In addition, the caribou is a significant subsistence resource for local people along the Arctic Coastal Plain (USFWS 1982; Cuccarese et al. 1984; Hensel et al. 1984). The three mammal species discussed may be exposed to COCs at the Oliktok Point installation and are evaluated in this ERA.

3.2.2.5 Threatened and Endangered Species. The threatened and endangered species that potentially occur at the DEW Line installations are the spectacled eider and Steller's eider. The spectacled eider is federally listed as threatened, and Steller's eider is a candidate for listing as threatened. The U.S. Fish and Wildlife Service indicated that it was likely that Steller's eider would be listed as threatened sometime in 1995 (Ambrose 1994 pers. comm.), however, a federal moratorium on additions to the threatened and endangered lists is in effect. Alaska Biological Research (1994) conducted surveys searching for spectacled and Steller's eiders on and near the DEW Line installations. The surveys report that there is potential for both species to be present in the vicinity of Oliktok Point because suitable nesting and/or brood-rearing habitat exists. Neither species was sighted during the surveys, but a 1993 nest site was believed to be a spectacled eider nest. The spectacled eider will be evaluated in this ERA. Because of the ecological similarity of spectacled and Steller's eiders (i.e., relatively similar morphology, physiology, niche, and trophic status), the evaluation of the spectacled eider will serve as a surrogate risk indicator for Steller's eiders in the event that the Steller's eiders are exposed to COCs at the Oliktok Point installation. The arctic peregrine falcon, *Falco peregrinus tundrius*, was delisted by the USFWS on 5 October 1994.

3.2.3 Exposure Pathways

This section discusses potential exposure pathways for ecological receptors. In addition, methods used to quantify exposures to selected species of plants, aquatic organisms, birds, and mammals are presented. Quantitative estimates of exposure will be compared with TRVs derived in Section 3.3 to estimate risks in the risk characterization section (Section 3.4).

Ecological receptors can be exposed to COCs through abiotic and biotic media. Potential exposure pathways for terrestrial and aquatic organisms are summarized in Figure 3-1. The following sections describe the potential exposure routes and a determination of pathways evaluated in the risk assessment.

Potential risks to representative species of plants from exposure to COCs in soil and water will be addressed. The most significant route of exposure for plants is direct contact with soil at the site, although a qualitative evaluation of the effects of COCs in surface water is presented in Section 3.4.1.

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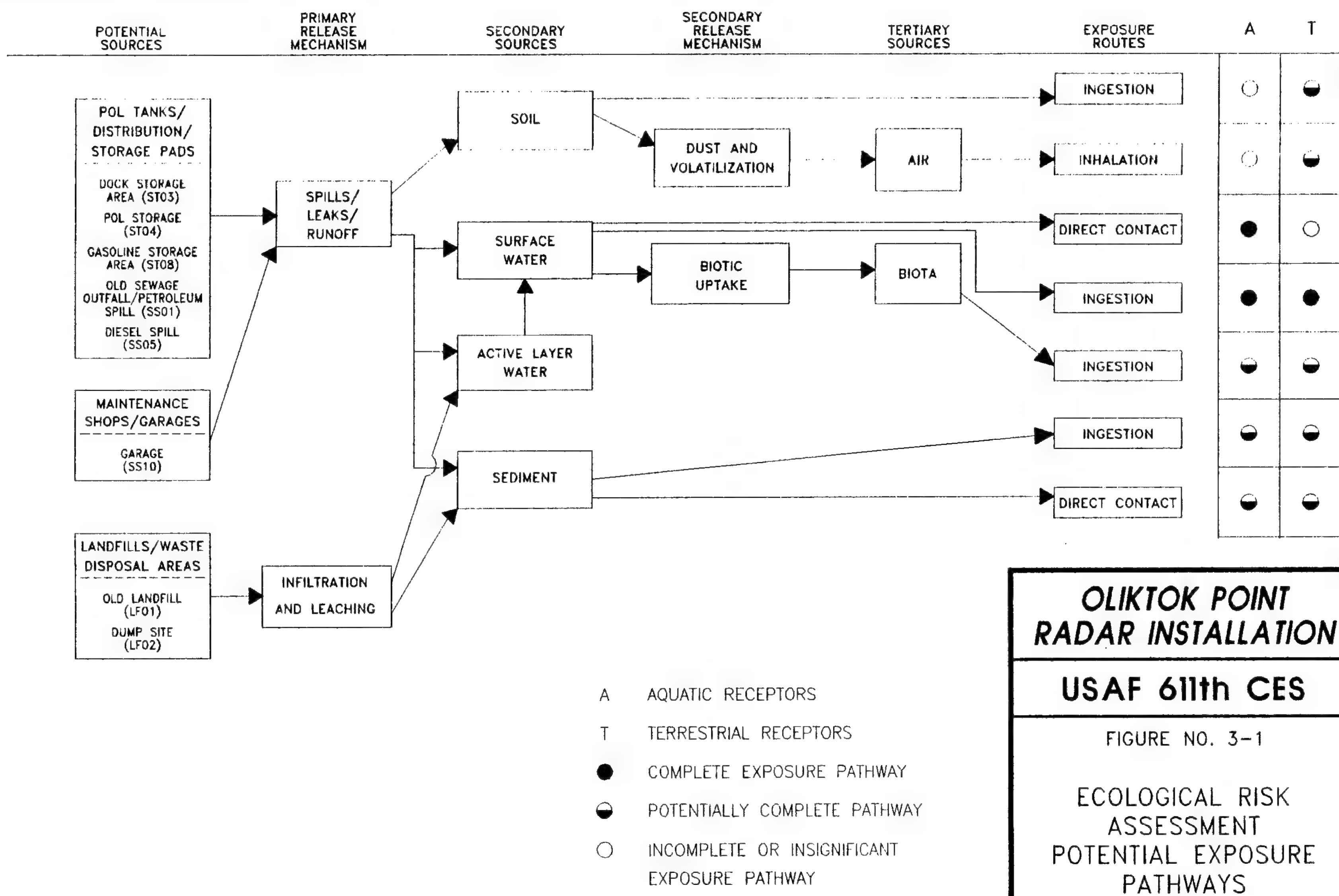

OLIKTOK POINT RADAR INSTALLATION

USAF 611th CES

FIGURE NO. 3-1

ECOLOGICAL RISK ASSESSMENT POTENTIAL EXPOSURE PATHWAYS

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Aquatic organisms such as fish and invertebrates are primarily exposed through direct contact with surface water. Surface water is in direct contact with dermal surfaces as well as gills and other respiratory structures. Fish and invertebrates also may be exposed to COCs through ingestion of plant and animal items in the diet, direct contact with sediments, and incidental ingestion of sediments while foraging. Direct contact with surface water is the primary exposure route, however, and these secondary routes will not be evaluated for aquatic organisms.

Birds and mammals may be exposed to COCs through a variety of pathways including ingestion of surface water used for drinking, ingestion of plant and animal diet items, and incidental ingestion of surface soils and sediments while foraging. Wildlife species are not expected to be exposed to COCs via inhalation because the surface soils are well vegetated and moist during the growing season and frozen and/or snow covered the remainder of the year. Therefore, this pathway is not evaluated in the ERA.

Insufficient toxicity and exposure information is available for the representative species to allow quantification of exposures from dermal contact with soil or sediments; therefore, these pathways were not quantitatively evaluated. Because soils and sediments represent potential pathways, total exposures for the representative species could be underestimated. This represents one of the uncertainties discussed in Section 3.5.

The soil and sediment samples at the Oliktok Point installation are taken at depths ranging from the surface to four feet deep. Only samples at depths of 1.5 feet or less were used in the ecological risk assessment because the potential exposure pathways for the representative species are likely to be incomplete at depths greater than 1.5 feet. It is unlikely that any of the representative species would be exposed to soil or sediments much below one foot, although the brown lemming is reported to burrow up to one foot deep (Nowak 1991).

3.2.4 Habitat Suitability for Representative Species

In order to assess the representative species' degree of exposure to the COCs, the habitat suitability of each of the eight sites was evaluated. The habitat suitability evaluation considered the representative aquatic, avian, and mammalian species at the Oliktok Point installation.

Human development and activities at the Oliktok Point installation have impacted the natural habitats available to the representative species. The effects of these impacts are uncertain; in some cases the activities probably deter wildlife use of the area and in other cases they may attract wildlife (e.g., arctic fox and gulls attracted to a landfill). Although these impacts may affect how and when representative species may use the habitats at Oliktok Point, the impacts are not subject to quantification, and as a result, all the sites at the Oliktok Point installation are evaluated in this ERA. In some cases, the media-specific samples have been taken at locations that do not represent suitable habitat for all the representative species (e.g., under-building sample locations that are obviously not suitable for caribou, or surface water sample locations that are not suitable for fish species). This may result in an overestimate of exposure because sample data from all locations (unless specifically noted in Section 3.1) are used to calculate the average concentrations which, in turn, are used to estimate exposure for the representative

species. These conditions will be noted in the risk characterization and uncertainty discussions (Sections 3.4 and 3.5, respectively).

The ERA is being conducted for the entire Oliktok Point installation, but only a portion of the facility consists of potentially contaminated sites. The sites are estimated to total approximately 7.5 hectares (ha), or 18.5 acres. The areal extent of the potentially contaminated sites has been estimated using site maps. The spatial extent of the sites is considered when estimating the onsite dietary intake (IS) in Section 3.2.7.2. In general, based on professional judgement and onsite observations, but not on site-specific surveys, the installation provides habitat less suitable than nearby areas because of the numerous roads, gravel pads, and overall development.

3.2.5 Exposure Assessment for Representative Species of Plants

The harsh environment of the Arctic Coastal Plain imposes many restrictions on plant life. The presence of permafrost limits infiltration and percolation of water, so the water table is often at or near the surface. The vast majority of plant species are perennial, with much of their biomass (50 to 98 percent) underground (Raven et al. 1986). The potential pathways of contamination for plants are through the soil/sediment and surface water.

Carex spp., *Salix* spp., and *Eriophorum* spp. all store food reserves in rhizomes. Mychorrhizal fungi play an important role in the transport and delivery of nutrients to the rhizomes and the roots of these species. This underground system probably developed in response to the harsh aboveground arctic environment. Surface water contaminated with chemicals that are lighter than water (i.e., petroleum and its derivatives) does not present a greatly increased hazard to the below-ground portion of plants. This has been shown experimentally by exposing arctic coast vegetation to petroleum products (Walker et al. 1978). The experiments showed that sedges, willows, and cottongrass plants were not adversely affected by low to moderate amounts (spill concentrations in the studies were up to 12 L/m^2) of petroleum in wet environments. Thus, soil/sediment will be considered the primary pathway of potential contamination for plants. The chemical concentration used in the risk characterization (Section 3.4) is the average concentration of the COC in the soil/sediments at the installation. A qualitative evaluation of the effect of potentially contaminated surface water on plants is presented in Section 3.4.1.

3.2.6 Exposure Assessment for Representative Aquatic Organisms

Organisms that dwell in an aquatic environment are exposed to chemicals contained in the water column. For this reason, the exposure assessment considers the concentrations in surface water to be the exposure concentrations to aquatic organisms. As described in Section 3.2.3, the primary exposure route for aquatic organisms is direct contact with surface water. As a result, the aquatic representative species are not evaluated for contact with, or ingestion of, sediments. The risk assessment compares the average concentration of the COCs found in surface waters to toxicity data for the representative aquatic species to calculate the risk estimate.

3.2.7 Exposure Estimates for Representative Bird and Mammal Species

Exposure estimates for representative species of mammals and birds (expressed as a unit of chemical ingested per unit of body weight) are based on their total exposure to COCs from diet, soils, and surface water using the following equation:

$$EE = [(FI \times CF) + (WI \times CW) + (SI \times CS \times ROA)] \times UCF \times IS / BW$$

where:

EE	=	estimated exposure (mg/kg-bw/day).
FI	=	food intake rate (g/day); rates are derived in the life history tables. Diets (both vegetable and animal components) are proportioned according to the diet composition information in the life history tables and are presented below.
CF	=	chemical concentration in food (mg/kg); based on concentrations for each group of food items.
WI	=	water intake rate (L/day); rates are derived in the life history tables.
CW	=	chemical concentration in water (µg/L); see Section 3.1 for calculations of concentrations.
SI	=	soil/sediment intake rate (g/day); based on a percentage of food intake.
CS	=	chemical concentration in soil/sediment (mg/kg); see Section 3.1 for calculations of concentrations.
ROA	=	relative oral availability; default to 1.0 (lack of information). This value assumes that the bioavailability of the chemical in the test medium is the same as for the medium onsite.
UCF	=	0.001; unit conversion factor used to convert g to kg, µg to mg, and L to ml to ensure EE is reported in mg/kg-bw/day.
IS	=	fraction of dietary intake at potentially contaminated sites (by weight).
BW	=	body weight (kg).

In the case of species that have partial herbivorous dietary intakes, the CF x FI phrase in the equation is multiplied by the proportion of vegetation in their diet (these calculations are presented in Appendix C, Bioconcentration Factor Calculation, and Appendix D, Concentration in Food Calculations). Those species and their respective proportions are: Lapland longspur, 0.25; brant, 0.90; glaucous gull, 0.10; pectoral sandpiper, 0.10; and spectacled eider, 0.25 (see the life history tables for references regarding the proportion of vegetation in the species' diets). The Estimated Exposure Calculations for bird and mammal receptors are presented in Appendix E.

3.2.7.1 Potential Bioaccumulation of COCs in Representative Species. The potential risks from ingestion of COCs in dietary items are difficult to determine because of the complexity of the trophic web. Inputs to the exposure estimate equation include concentrations of contaminants in water and soil, ingestion rates for water, food, and soil; the relative use of the potentially contaminated sites compared to the representative species' normal range; and body weight. The food ingested, in the case of higher level consumers, may be from different levels

of the trophic web. For example, a contaminant may be taken up by a plant that is consumed by a lemming, which is then eaten by an arctic fox. The amount of contaminant to which the fox is exposed is not readily quantified without supporting empirical data at each trophic level. Because data is lacking to assist in quantifying bioaccumulation, the risk assessment does not account for bioaccumulation in the animal portion of the trophic web. This uncertainty is tempered by the "hot spot" nature of the distribution of the COCs. It is possible that representative species may be exposed to these "hot spots" occasionally, but it is unlikely that their entire exposure will occur at these locations. Use of the average concentrations to estimate exposure may overestimate the potential exposure of representative species (this is discussed in more detail in the ERA Uncertainty Analysis, Section 3.5.1). Furthermore, the likelihood of predators repeatedly taking prey that were exposed to a COC "hot spot" is low. For example, the arctic fox ranges over such a wide area that any COCs to which the fox would be exposed via bioaccumulation would represent only a very small proportion of its overall exposure.

Further, most of the COCs in soils/sediments at the Oliktok Point installation are organic compounds unlikely to bioaccumulate. For illustrative purposes, bioconcentration factors (BCF) calculated (Veith et al. 1979 in Spacie and Hamelink 1985) for the organic COCs are presented in Table 3-4. The exposure estimates for organic chemicals do not include potential bioaccumulation of COCs in the animal portion of the trophic web. It is unlikely that the organic chemicals will bioaccumulate (based on the concentrations reported in the soil/sediment and water), such that the exposure estimates would exceed, or even approach, the TRVs.

The inorganic COCs at Oliktok Point are lead and manganese in soil/sediment. The bioaccumulation of metals in the animal portion of the trophic web is not amenable to quantification without sample concentrations at each level of consumer. The following qualitative discussions address the potential bioaccumulation of the inorganic COCs at the Oliktok Point installation.

Lead. Lead tends to accumulate in bone (Talmadge and Walton 1991), so ingestion of animal tissue would not contribute greatly to increased lead concentrations. Food chain biomagnification of lead is uncommon in terrestrial communities (Eisler 1988). Kraus (1989)

TABLE 3-4. BIOCONCENTRATION FACTORS FOR SELECTED ORGANIC COMPOUNDS IN WATER

CHEMICAL	Log K_{ow}	BCF
Benzene	2.13	25
Tetrachloroethene	2.53	49
Xylene	3.16	149

Note: BCF calculated from Log K_{ow} according to the following equation:
Log BCF = 0.76 Log K_{ow} - 0.23 (Veith et al. 1979 in Spacie and Hamelink 1985)
K_{ow} = octanol/water partition coefficient

showed that in environments that were high in lead, the concentration of lead in insects and the tissues of insectivorous birds was low. Thus, lead is not likely to bioaccumulate to a degree that could contribute to risk at the Oliktok Point installation.

Manganese. Manganese is an essential nutrient (ATSDR 1990). It is not likely that the concentrations of manganese found at the Oliktok Point installation would bioaccumulate because this mineral is regulated for metabolic use by the representative species.

3.2.7.2 Estimation of Percent Ingested Onsite. The size of the areas used by the representative species, and hence their potential exposure to COCs, varies greatly. Generally, a species' home range is used to characterize the size of the area it uses on a regular basis (disregarding migration and dispersal). When home range information for a species was not available, population density values were used to estimate the area used by the species. This information, combined with the extent of the potentially contaminated sites, can be used to estimate the percent of dietary intake that a species gets from the sites.

This estimate is referred to as the "percent of dietary intake at sites" (IS) value in the exposure estimate equation. The IS value is represented by the ratio of the total area of the sites (7.5 ha or 18.5 acres) to the reported home range size (or converted population density values) for the representative species. The representative species are most likely to be at Oliktok Point during, or directly after, the breeding season, when many species become territorial. These territories represent the area used by the species. The densities of the population may provide estimates of the size of the territories and are used as substitute values when home range information is unavailable. This presents an added degree of uncertainty (see Section 3.5.3). If the home range (or converted population density value) is less than the total areal extent of the sites (7.5 ha), the maximum value for IS is 1.0 because it is possible that a species could meet all its dietary intake needs within the potentially contaminated areas. The IS values for the representative bird and mammal species are given below. Note that these are conservative estimates because the 7.5 ha size assumes that the contaminated sites are the only areas used. Obviously, the species would use the suitable areas between the potentially contaminated sites, resulting in lower potential exposure to COCs than if the species restricted its location to contaminated sites only.

Birds. Lapland longspur. IS = 0.5; Derksen et al. (1981) report a breeding density of 38.6 birds/km^2. This corresponds to about 1 bird/2.6 ha. Potentially, the longspur could meet all of its dietary demands within the potentially contaminated sites. Nevertheless, an IS value of 0.5 is used because the longspur prefers drier upland habitat and shrublike vegetation instead of the wetter areas and unvegetated gravel pads where the majority of contaminant pathways occur.

Brant. IS = 0.38; density of breeding pairs reported by Derksen et al. (1981) is 5.0 birds/km^2. At this density of 1 brant/20 ha, the total extent of the potentially contaminated sites is about 38 percent of the area a brant might use.

Glaucous gull. IS = 0.06; the density for the glaucous gull is reported by Derksen et al. (1981) as 0.8 birds/km^2. This density, about 1 gull/125 ha, yields an IS value of 0.06, indicating that the potentially contaminated sites are about six percent of the area the glaucous gull uses.

Pectoral sandpiper. IS = 1.0; the density of the pectoral sandpiper along the Arctic Coastal Plain is reported by Derksen et al. (1981) as 22.4 birds/km^2. This density equates to one sandpiper/4.5 ha, and a corresponding IS value of 1.0, which indicates that the sandpiper could meet all its needs within the total area of the potentially contaminated sites.

Spectacled eider. IS = 0.02; Derksen et al. (1981) report an average population density of 0.32 birds/km^2 for the spectacled eider. The resulting density of 1 bird/312.5 ha in 1981 is currently too high considering the decline in the species' population. The resulting IS value of 0.02 may result in an overestimation of potential exposure, but an overestimation may be considered acceptable in the evaluation of a sensitive species.

Mammals. Brown lemming. IS = 0.5; the lemming's home range is reported as 0.5 ha (Nowak 1991). It is possible that several lemmings may consume all their dietary needs within the bounds of a site. The lemming is not likely, however, to use the wetter sites (which constitute a large portion of the total extent of the sites) where the majority of the contaminant pathways are located. Also, the potentially contaminated sites are mostly gravel pads that have been constructed for development purposes, support little or no vegetation, and offer a poor matrix for the lemming to use for burrowing. For these reasons the IS used for the brown lemming is 0.5 rather than 1.0.

Arctic fox. IS = 0.02; the home range of the fox is extremely variable. Eberhardt et al. (1982) report a home range of 3.7 to 20.8 km^2 (370 to 2080 ha) for juvenile and adult arctic foxes, respectively. Using the lower end of the reported range (370 ha), results in an IS value of 0.02.

Caribou. IS = 0.01; caribou are highly mobile, covering large distances during their movements to and from calving grounds and in their constant search for suitable forage. They may range over thousands of kilometers a year, and as a result there is no accurate estimate of their home range. Based on professional judgement and knowledge of the caribou's habits, a very conservative (likely to overestimate exposure) IS value of 0.01 is used for the caribou.

3.2.7.3 Exposure Assessment for Representative Species of Birds. In this section the methods for quantifying exposures to the selected representative species of birds are presented.

In order to estimate exposures of the representative species of birds, life history information was compiled for the selected species. This information includes occurrence at the DEW Line sites, habitat, average body weight, estimated food intake rate, estimated water intake rate, diet composition, and home range and/or population density.

Plant uptake of contaminants has been quantified for use in the exposure estimations for herbivores (bird and mammal species). Herbivores are potentially exposed to contamination directly from ingestion of soil and water intake as well as through their diet. The dietary plant component (CF in the exposure estimate equation) is calculated by multiplying the contaminant's soil concentration by the BCF, B_v. B_v is defined as the ratio of the concentration in aboveground parts of a plant (mg of compound/kg of dry plant) to the concentration in soil (mg of compound/kg of dry soil). The B_v can be used to predict the level of a potential contaminant

taken up by a plant, and this information can then be used to assess the potential transport of the contaminant in the trophic web.

The uptake of metals by plants is quantified using the B_v values in Baes et al. (1984). These values represent potential uptake to the vegetative portions of the plant. The approach for organic chemicals is basically the same, except that the B_vs for organic chemicals are derived using a regression equation (Travis and Arms 1988). The equation is:

$$\log B_v = 1.588 - 0.578(\log K_{ow})$$

where:

B_v = the BCF (unitless) and
K_{ow} = the octanol-water partition coefficient of the chemical (mol/m^3 / mol/m^3).

In order to calculate the potential uptake of DRPH by plants, the K_{ow} of diesel fuel was estimated. The estimation of the K_{ow} was conducted using equation 2-3 in Lyman et al. (1982):

$$\log S = -0.922 \log K_{ow} + 4.184$$

where:

S = solubility (mg/L) and
K_{ow} = octanol/water partition coefficient (mol/m^3 / mol/m^3).

This equation estimates the solubility of an organic chemical in water. It may also be manipulated arithmetically to calculate the log K_{ow} based on the known solubility:

$$\log K_{ow} = \frac{\log S - 4.184}{-0.922}$$

The solubility of diesel fuel (0.2 mg/L) (Custance et al. 1992) was used to calculate the log K_{ow} of diesel fuel. The log K_{ow} is calculated to be 5.3.

Life history information for the Lapland longspur, brant, glaucous gull, pectoral sandpiper, and spectacled eider (although the spectacled eider is a threatened species, it is presented with the other avian species) is presented in Tables 3-5 through 3-9.

Information is not available on the daily food intake rate (grams/day) and water intake rate (liters/day) for the representative bird species in the arctic habitat. Therefore, this information was estimated using regression equations associated with body weight (Nagy 1987 for food intake rates; Calder and Braun 1983 for water intake rates). The severity of the arctic climate may impose higher metabolic demands on animals. As a result, the food and water intake rates should be considered to be estimates only, and their uncertainty should be kept in mind. The food intake rate was estimated using Nagy's (1987) equations:

Passerine birds (i.e., Lapland longspur):

$$FI \text{ (kg/day dry matter)} = 0.141 \times (\text{body weight in kilograms})^{0.850}$$

TABLE 3-5. LIFE HISTORY INFORMATION FOR THE LAPLAND LONGSPUR, *Calcarius lapponicus*

PARAMETER	VALUE	NOTES	REFERENCE
Occurrence at DEW Line Sites	Seasonal breeder at all arctic coastal radar installations	Dominant breeding passerine	U.S. Air Force 1993
Habitat	Breeds on arctic coastal tundra		Scott 1983
Body Weight	27.3 g (0.027 kg)	Mean of 68 specimens	Dunning 1984
Food Intake Rate	6.5 g/day dry matter	$FI = 0.141 (BWkg)^{0.850}$	Nagy 1987
Water Intake Rate	0.005 liters/day	$WI = 0.059 (BWkg)^{0.67}$	Calder and Braun 1983
Diet Composition	During breeding (June and July): insects (craneflies); pre- and post-breeding (May and August): seeds (grasses); average 25 percent vegetation in diet	Passerine member of insectivorous foraging guild which includes shorebirds	Custer and Pitelka 1978
Population Density	38.6/km^2	Varies with changing predation pressures	Derksen et al. 1981

TABLE 3-6. LIFE HISTORY INFORMATION FOR THE BRANT, *Branta bernicla*

PARAMETER	VALUE	NOTES	REFERENCE
Occurrence at DEW Line Sites	Seasonal breeder at all arctic coastal radar installations	Breeding, migratory sp., subsistence sp.	U.S. Air Force 1993
Habitat	Breeds on Arctic Coastal Plain	Prefers low, barren, wet, coastal terrain	Palmer 1976
Body Weight	1,305 g (1.305 kg)	Mean of 791 specimens	Dunning 1984
Food Intake Rate	69.2 g/day dry matter	$FI = 0.0582 (BWkg)^{0.651}$	Nagy 1987
water Intake Rate	0.07 liters/day	$WI = 0.059 (BWkg)^{0.67}$	Calder and Braun 1983
Diet Composition	Sedges, grasses; average 90 percent vegetation in diet	Some insects during breeding (June and July)	Palmer 1976
Population Density	5.0/km^2	Average from three coastal sites	Derksen et al. 1981

TABLE 3-7. LIFE HISTORY INFORMATION FOR THE GLAUCOUS GULL, *Larus hyperboreus*

PARAMETER	VALUE	NOTES	REFERENCE
Occurrence at DEW Line Sites	Seasonal breeder at all arctic coastal radar installations	Relatively common along arctic coast	Woodward-Clyde 1993
Habitat	Coastal tundra, lakes, ponds, and marine environment	Breeds on arctic coast	Farrand 1983
Body Weight	1,445 g (1.445 kg)	Mean of 65 specimens	Dunning 1984
Food Intake Rate	74 g/day dry matter	$FI = 0.0582\ (BWkg)^{0.651}$	Nagy 1987
Water Intake Rate	0.08 liters/day	$WI = 0.059\ (BWkg)^{0.67}$	Calder and Braun 1983
Diet Composition	Small fish, birds, insects, crustaceans, mollusks, garbage; average 10 percent of vegetation in diet	Predatory scavenger	Martin et al. 1961
Population Density	$0.8/km^2$	Average from three coastal sites	Derksen et al. 1981

TABLE 3-8. LIFE HISTORY INFORMATION FOR THE PECTORAL SANDPIPER, *Calidris melanotos*

PARAMETER	VALUE	NOTES	REFERENCE
Occurrence at DEW Line Sites	Seasonal breeder at all arctic coastal radar installations	Abundant on Arctic Coastal Plain	Woodward-Clyde 1993
Habitat	Grassy margins of wet meadows, marshes, riparian areas, ponds	Nests hidden on well-drained grassy sites	Scott 1983; Martin et al. 1961
Body Weight	79 g (0.079 kg)	Mean of 35 specimens	Dunning 1984
Food Intake Rate	11.2 g/day dry matter	$FI = 0.0582\ (BWkg)^{0.651}$	Nagy 1987
Water Intake Rate	0.01 liter/day	$WI = 0.059\ (BWkg)^{0.67}$	Calder and Braun 1983
Diet Composition	Insects, mollusks, crustaceans, worms, vegetable debris; average 10 percent vegetation in diet	Craneflies are major diet component	Martin et al. 1961; Pitelka 1959
Population Density	$22.4/km^2$	Average from three coastal sites	Derksen et al. 1981

TABLE 3-9. LIFE HISTORY INFORMATION FOR THE SPECTACLED EIDER, *Somateria fischeri*

PARAMETER	VALUE	NOTES	REFERENCE
Occurrence at DEW Line Sites	Potential seasonal breeder at all arctic coastal radar installations	Winter whereabouts unknown	Woodward-Clyde 1993; Alaska Biological Research 1994
Habitat	Marine when not breeding, nests on coastal tundra	Nests on islets in tundra ponds and lakes, as well as ashore	Palmer 1976
Body Weight	1,375 g (1.375 kg)	Mean of 32 specimens	Dunning 1984
Food Intake Rate	71.6 g/day dry matter	$FI = 0.0582 (BWkg)^{0.651}$	Nagy 1987
Water Intake Rate	0.07 liters/day	$WI = 0.059 (BWkg)^{0.67}$	Calder and Braun 1983
Diet Composition	75 percent insects, mollusks, crustaceans; average of 25 percent plant matter in diet	Mostly insects when they are abundant; June and July	Kistchinski and Flint 1974
Population Density	$0.32/km^2$	Average of three coastal sites	Derksen et al. 1981

All other birds:

$$FI \text{ (kg/day dry matter)} = 0.0582 \times \text{(body weight in kilograms)}^{0.651}$$

The water intake rate was estimated using the regression equation developed by Calder and Braun (1983):

All birds:

$$WI \text{ (liters/day)} = 0.059 \times \text{(body weight in kilograms)}^{0.67}$$

As animals forage they may incidentally ingest soil and sediment particles. The average concentration of contaminants in soil/sediment can be multiplied by the amount of soil/sediment ingested to estimate the potential uptake of contaminants by this route. Soil intake rates have been reported for just a few wildlife species (Beyer et al. 1994). The soil ingestion rates for the representative species are extrapolated from Beyer et al. (1994) by using similar species with reported values. The percentages reported are of the total weight of dietary intake. Table 3-10 lists the representative and sensitive bird species, the species used as surrogates, and the estimated percentages of soil ingested in quantifying exposure to contaminants. Species that forage directly in the soil or sediment, such as the sandpiper or goose, show relatively high percentages of soil in their diet. The Lapland longspur does not have appropriate surrogate species with soil ingestion data. Although the longspur is in the same foraging guild as sandpipers (which incidentally ingest relatively large amounts of soil), the longspur takes insects

TABLE 3-10. SOIL INGESTION ESTIMATES FOR REPRESENTATIVE AND SENSITIVE BIRD SPECIES

REPRESENTATIVE SPECIES	SURROGATE SPECIES	ESTIMATED PERCENT OF SOIL IN DIET	ESTIMATED SOIL IN DIET (g/day)
Lapland longspur	No suitable surrogate	<2.0	0.1
Brant	Canada goose	8.2	5.7
Glaucous gull	Siberian glaucous gull[a]	7.6	5.6
Pectoral sandpiper	Four sandpiper species (average)	18.1	2.0
Spectacled eider	Canada goose	8.2	5.9

a Data from Belopol'skii 1961.
Source: Beyer et al. 1994.

from the soil surface or gleans its prey from vegetation (Custer and Pitelka 1978), thus minimizing its soil intake; the estimate of soil ingestion (less than two percent of diet by weight) reflects this. The glaucous gull ingests stones and sand as a mechanical addition (to aid in digestion) to its diet (Belopol'skii 1961), and this contributes to its soil/sediment intake. For those species without a suitable surrogate or whose soil ingestion rate is reported as <2 percent, a value of two percent of dietary intake (by weight) was used to calculate the exposure estimates.

3.2.7.4 Exposure Assessment for Representative Species of Mammals. This section assesses exposure to contaminants for the selected representative species of mammals. Table 3-11 (brown lemming), Table 3-12 (arctic fox), and Table 3-13 (caribou) present life history data that are used to calculate exposure estimates for the representative mammalian species. Home range and/or population density has been listed for the representative mammal species, depending on appropriateness and availability.

Information on daily food intake rates for the arctic fox and caribou was not available. The rates have been estimated using regression equations associated with average body weights and metabolic rates (Nagy 1987). The food intake rates for the fox and caribou were estimated using the following equations, developed for placental mammals in general and for herbivorous mammals, respectively (Nagy 1987).

arctic fox: using equation for placental mammals in general

$$\text{FI (kg/day dry matter)} = 0.0687 \times (\text{body weight in kilograms})^{0.822}$$

caribou: using equation for mammalian herbivores

$$\text{FI (kg/day dry matter)} = 0.0875 \times (\text{body weight in kilograms})^{0.727}$$

Because of very low assimilation efficiencies, the low nutrient content of winter forage, and the high metabolic demands in arctic habitats (Chappell 1980), the equation for food intake rate

TABLE 3-11. LIFE HISTORY INFORMATION FOR THE BROWN LEMMING, *Lemmus trimucronatus*

PARAMETER	VALUE	NOTES	REFERENCE
Occurrence at DEW Line Sites	Resident at all arctic coastal radar installations	Dominant small mammal	U.S. Air Force 1993
Habitat	Tundra and alpine meadows	Nests above ground in winter, below in summer	Burt and Grossenheider 1976
Body Weight	55 g (0.055 kg)		Chappell 1980
Food Intake Rate	24-45 g/day dry matter	Has low assimilation efficiencies (31 to 36 percent), variation related to seasons	Chappell 1980
Water Intake Rate	0.007 liters/day	$WI = 0.099\ (BWkg)^{0.90}$	Calder and Braun 1983
Diet Composition	Sedges, grasses, lichens, roots, leaves, bark, berries		Nowak 1991
Home Range Size (AVG)	0.5 ha (females) 1.0 ha (males)	0.5 ha used in assessment	Nowak 1991
Population Density	0 to 325/ha	Populations have large fluctuations on a three to five year cycle; currently populations are low	Nowak 1991; Snyder-Conn 1994

TABLE 3-12. LIFE HISTORY INFORMATION FOR THE ARCTIC FOX, *Alopex lagopus*

PARAMETER	VALUE	NOTES	REFERENCE
Occurrence at DEW Line Sites	Resident at all arctic coastal radar installations	Ubiquitous	U.S. Air Force 1993
Habitat	Tundra and coastal plain	Dens in sandy mounds >1 m high	Chesemore 1967
Body Weight	4950 g (4.95 kg)		Burt and Grossenheider 1976
Food Intake Rate	256 g/day dry matter	$FI = 0.0687\ (BWkg)^{0.822}$	Nagy 1987
Water Intake Rate	0.42 liters/day	$WI = 0.099\ (BWkg)^{0.90}$	Calder and Braun 1983
Diet Composition	Brown lemming (summer), nesting birds, carrion, seal pups, non-food items	brown lemming in >85 percent of all scats, n=224	Chesemore 1967; Nowak 1991
Home Range Size (AVG)	20.8 km^2 adult 3.7 km^2 juvenile (<1 yr)	Adult range used in assessment	Eberhardt et al. 1982

TABLE 3-13. LIFE HISTORY INFORMATION FOR THE BARREN-GROUND CARIBOU, *Rangifer tarandus*

PARAMETER	VALUE	NOTES	REFERENCE
Occurrence at DEW Line Sites	Seasonal, at or near all arctic coastal radar installations during migrations	Areas near some installations used for calving	U.S. Air Force 1993
Habitat	Tundra in summer, open coniferous forest in winter	Varies, related to migration	Burt and Grossenheider 1976
Body Weight	95,500 g (95.5 kg)	Mean for adults	Nowak 1991
Food Intake Rate	2,400 g/day (2.4 kg) dry matter	$FI = 0.0875\ (BWkg)^{0.727}$	Nagy 1987
Water Intake Rate	6.0 liters/day	$WI = 0.099\ (BWkg)^{0.90}$	Calder and Braun 1983
Diet Composition	Willows, sedges, cottongrass, lichens	Selection based on plant phenology	Skogland 1980; White and Trudell 1980
Population Density	1.41 km^2 0.31 km^2 4.53 km^2	Undisturbed calving area Within 1 km of road Within 5 to 6 km of road	Cameron et al. 1992

significantly underestimates the rate for the brown lemming. A more appropriate rate for the brown lemming of 45 g/day is reported by Chappell (1980) (using the highest value in the reported range of 24 to 45 g/day).

The rates for water intake of the representative mammals were estimated using the regression equation generated by Calder and Braun (1983) because of the unavailability of species-specific information in the literature. The equation is:

$$WI\ (liters/day) = 0.099 \times (body\ weight\ in\ kilograms)^{0.90}$$

Incidental soil intake was evaluated for mammals in the same manner as for birds (Section 3.2.7.3). Table 3-14 shows the percent of soil ingested for the representative mammal species.

3.3 ECOLOGICAL TOXICITY ASSESSMENT

This section presents toxicity information for each COC in surface water and soil/sediment. The COCs identified in surface water are DRPH and GRPH (Section 3.1.1). The COCs in soil/sediment are DRPH, GRPH, RRPH, benzene, toluene, ethylbenzene, xylenes, benzyl alcohol, PCBs, lead, and manganese (Section 3.1.2). Sections 3.3.1 through 3.3.9 discuss the toxicity of

TABLE 3-14. SOIL INGESTION ESTIMATES FOR REPRESENTATIVE MAMMAL SPECIES

REPRESENTATIVE SPECIES	SURROGATE SPECIES	ESTIMATED PERCENT OF SOIL IN DIET	ESTIMATED SOIL IN DIET (g/day)
Brown lemming	White-tailed prairie dog	2.7	1.2
Arctic fox	Red fox	2.8	7.2
Caribou	Elk	<2.0	48

Source: Beyer et al. 1994.

all COCs to the receptor groups. Section 3.3.10 presents the methodology for the derivation of TRVs used in this ERA.

3.3.1 Petroleum Hydrocarbons

Petroleum hydrocarbons were identified as COCs in surface water (DRPH and GRPH) and soil/sediment (DRPH, GRPH, and RRPH). This section is a discussion of the chemical compositions of DRPH, GRPH, and RRPH and the toxicity of these petroleum mixtures.

Crude petroleum contains thousands of different chemical compounds. Gasoline and diesel fuel are refined petroleum products. The composition of gasoline and diesel fuel depends on not only the origin of the crude oil from which the gasoline is derived, but also the process technique and the blending scheme (Von Burg 1993). Once gasoline or diesel fuel is released to the environment, weathering and volatilization further alter its composition.

Gasoline is a complex, highly variable mixture of petroleum hydrocarbons containing 3 to 21 carbon atoms; however, compounds with 4 to 12 carbon atoms predominate. Gasoline is detected with the petroleum hydrocarbon analysis as GRPH. The following chemical classes are detected as GRPH: paraffins (straight-chained alkanes), olefins (straight-chained alkenes), naphthenes (cycloalkanes and alkenes), and aromatic hydrocarbons [alkylbenzenes and polycyclic aromatic hydrocarbons (PAHs)] (Von Burg 1993). Although GRPH are generally in the range of 4 to 12 carbon atoms, the laboratory that conducted the analyses for Oliktok Point detected GRPH with 6 to 9 carbon atoms. As many as 140 compounds have been identified as constituents of gasoline; however, constituents such as benzene drive the toxicity. Diesel fuel is also a complex, variable mixture of the same classes of compounds containing 6 to 21 carbon atoms. Diesel fuel is detected with the petroleum hydrocarbon analysis as DRPH. The laboratory that analyzed samples for Oliktok Point detected DRPH with 10 to 24 carbons atoms. As many as 45 compounds have been identified as constituents of diesel fuel (Von Burg 1993). RRPH includes many different types of chemicals, although the majority of compounds include 24 carbon atoms or more.

Table 3-15 presents the chemical classes and weight percent for GRPH and DRPH. Generally, gasoline contains more aromatic compounds and simple chained alkanes, whereas diesel fuel

TABLE 3-15. CHEMICAL CLASSES OF GRPH AND DRPH

CHEMICAL CLASS	WEIGHT PERCENT[a]
GRPH[b]	
Normal paraffins (n-alkanes)	19.3-38.4 (28.8)
Isoparaffins (isoalkanes)	11.5-50.3 (30.9)
Naphthenes (cycloparaffins or cycloalkanes)	1.0-2.8 (1.9)
Aromatics (e.g., benzene, toluene, pyrene)	9.7-54.7 (32.2)
DRPH[c]	
Normal paraffins (n-alkanes)	5.6
Isoparaffins (isoalkanes)	11.1
Naphthenes (cycloparaffins or cycloalkanes)	46.3
Aromatics (e.g., benzene, toluene, pyrene)	33.3
Nitrogen, sulfur and oxygen compounds	3.7

a Average shown in parentheses.
b Heath et al. 1993.
c Weeks et al. 1988.

is characterized by cycloparaffins (or cycloalkanes). Both gasoline and diesel fuel will be affected by the environment. Weathering will change the chemical composition of petroleum, and concentrations of aromatic compounds such as benzene will decrease as a result of volatilization.

Available toxicity test data have been derived from pure, fresh product, and therefore the applicability to the weathered product encountered at Oliktok Point is uncertain. Gasoline is the most studied of the petroleum products; however, most data are based on inhalation studies. Gasoline was classified by EPA (1992c) as a Group C (possible human) carcinogen, whereas diesel oil was classified as Group D (not classifiable as to human carcinogenicity). Presumably, this classification of gasoline is due to benzene, which, under the conditions of environmental exposure, would volatilize more rapidly than any other constituent. Physical-chemical data from the literature indicates that TPH in soil would reflect all constituents with eventual loss of aromatic (e.g., BTEX) components first, lighter alkanes second, lighter PAHs third, followed by naphthalenes. For an old diesel or petroleum spill, petroleum hydrocarbon measurements may reflect predominantly trace amounts of high molecular-weight PAHs or higher molecular-weight and branched alkanes [Massachusetts Department of Environmental Protection (MDEP) 1993].

For the purposes of ranking the toxicity of GRPH, DRPH, and RRPH, it was assumed that BTEX and lighter-weight alkanes are significantly weathered from exposure to the arctic environment and that toxicity is more dependent upon noncarcinogenic endpoints associated with alkanes,

alkenes, and cycloalkanes. In addition, the toxicity of DRPH and RRPH is associated with the PAH content. However, at Oliktok Point, the only PAH detected was naphthalene, a chemical considered to be noncarcinogenic. Carcinogenic PAHs such as benzo(a)pyrene were not detected. MDEP (1983) reviewed the noncarcinogenic toxicological endpoints in laboratory animals for diesel fuel and gasoline and determined that diesel fuel was an order of magnitude more toxic than gasoline. Although other sources indicate that the toxicity of alkanes and cycloalkanes is similar (Armstrong Laboratory 1994; Sax and Lewis 1989). A review of the Oliktok Point data indicates that DRPH are present at higher concentrations than either GRPH or RRPH. Specifically, average concentrations of DRPH were approximately 48 times the average concentration of GRPH and 15 times the average of RRPH concentration. As a result, based on the MDEP review and the chemical data reported for the Oliktok Point surface water and soil/sediment samples, DRPH were used as a conservative representation of ecological risks from petroleum hydrocarbon contamination (i.e., GRPH and RRPH).

As discussed above, diesel fuel is comprised of a complex mixture of paraffins (straight-chained alkanes), olefins (straight-chained alkenes), naphthenes (cycloalkanes and alkenes), and aromatic (alkylbenzenes and polynuclear) petroleum hydrocarbons containing 6 to 21 carbon atoms. Hydrocarbons containing 8 to 18 carbon atoms predominate (Von Burg 1993). There are six grades of diesel fuel (Diesel Oil No. 1, Diesel Oil No. 2, Diesel Oil No. 4, Fuel Oil No. 1, Fuel Oil No. 2, and Home Heating Oil) (Von Burg 1993). The specific components of diesel are expected to change from source to source, so the toxicity of diesel fuels is expected to be variable. The following sections summarize the toxicity of diesel fuel to plants, aquatic organisms, birds, and mammals.

3.3.1.1 Plants. Petroleum released to the aquatic environment may be toxic to aquatic plants. Toxicity tests have shown that the water-soluble components of petroleum are toxic to an algal species (*Chlorella vulgaris*) (Kauss and Hutchinson 1975); however, in this specific study, the toxicity was short term. The algal community recovered after a "lag phase". It was theorized (Kauss and Hutchinson 1975) that this trend was due to the loss of highly volatile fractions from the testing chamber over time. Exposure to water extracts of No. 2 Fuel Oil depressed algal biomass in communities and resulted in blue-green algal dominance and decreased diatom occurrence (Bott and Rogenmuser 1978). No data was available concerning plant exposure to GRPH, but the data for DRPH will be used to evaluate the exposure to GRPH.

3.3.1.2 Aquatic Organisms. Moles et al. (1979) tested the acute toxicity of Prudhoe Bay crude oil to several Alaskan freshwater and anadromous fish. Salmonids were the most sensitive species tested, and demonstrated median tolerance limits [the concentration at which one half the organisms survive in 96 hours, same as LC_{50} (lethal concentration for 50 percent of the organisms)] ranging from 2.7 to 4.4 mg/L. The three-spined stickleback, *Gasterosteus aculeatus*, was more tolerant, with an LC_{50} of 10.4 mg/L. Klein and Jenkins (1983) studied the toxicity of the water-soluble fraction of jet fuel to fish. Growth of fry was retarded by 1.5 mg/L of the water-soluble fraction of JP-8 (jet fuel with de-icer). In a study conducted by Hedtke and Puglisis (1982), the method of introducing the oil to the test chamber was an important variable driving toxicity. Emulsified oils were substantially more toxic than either floating oils or the water-soluble fraction. The 96-hour LC_{50} for fathead minnows (*Pimephales promelas*) exposed to the emulsion of No. 2 Jet Fuel was 38.6 mg/L [concentration used to calculate the Toxicity Reference Value

(TRV) for GRPH and DRPH]. Because no toxicity data were available for GRPH and fish, the jet fuel data were used to evaluate the nine-spined stickleback's exposure to GRPH.

Aquatic organisms other than fish may also be exposed to diesel fuel in the environment. Studies have shown that freshwater arctic zooplankton may be more sensitive to oil pollution than any other arctic freshwater organisms (O'Brien 1978). Geiger and Buikema (1981) estimated an LC_{20} (concentration lethal to 20 percent of the test organisms) of No. 2 Fuel Oil to *Daphnia pulex* of 5.6 mg/L (concentration used to calculate TRV). These data are used to evaluate *Daphnia* exposure to GRPH.

3.3.1.3 Birds. Petroleum hydrocarbons in the environment may affect bird reproduction. External application of No. 2 Fuel Oil to mallard (*Anas platyrhynchos*) and common eider (*Somateria mollissima*) eggs significantly increased embryo mortality (Albers 1977; Szaro and Albers 1977). Mallard eggs were treated with 1, 5, 10, 20, and 50 μL of fuel oil. Ingestion of crude oil by mallards at a concentration of five percent by weight in the diet resulted in depressed growth (Szaro et al. 1978). Hartung (1964) demonstrated a decrease in weight gain in mallards during the first 10 days after receiving 6,000 mg/kg No. 2 Fuel Oil (concentration used to calculate the DRPH TRV); however, after 34 days, there was no difference between treatment groups and the controls. No toxicity data were available for avian exposure to GRPH specifically, but the evaluation of DRPH, in addition to a comparison of avian and mammalian GRPH toxicities (presented in Section 3.4.3, Risk Characterization), will serve to assess avian GRPH exposure.

3.3.1.4 Mammals. The toxicity of DRPH and GRPH to the representative mammals can be evaluated using the toxicity of the compound to rats. Diesel fuel is relatively nontoxic to rats based on an acute oral LD_{50} (lethal dose for 50 percent of the organisms) of 7,380 mg/kg (Beck et al. 1982) (dose used to calculate TRV). Based on subchronic renal studies using rats exposed to unleaded gasoline, a NOAEL of 500 mg/kg was reported (ATSDR 1993b). This dose was used to calculate the GRPH TRV for mammals.

3.3.2 Benzene

Benzene is a COC in soil/sediment at the Oliktok Point sites. It is an highly volatile aromatic hydrocarbon that is used as a solvent and in the synthesis of other chemicals. Benzene is typically a component of petroleum products as well as found naturally in the environment (ATSDR 1993a; Klaassen et al. 1986). The major toxic effect of benzene in animals is hematopoietic toxicity (i.e., blood disorders, including anemia and leukemia) (Klaassen et al. 1986). A summary of the relevant toxicity information is presented below.

3.3.2.1 Plants. No information was available concerning the toxicity of benzene to plants. A qualitative discussion of the toxicity of VOCs to plants in general is presented in Section 3.4.1, Risk Characterization.

3.3.2.2 Aquatic Organisms. No aquatic toxicity information is presented because benzene was not selected as a COC in surface water.

3.3.2.3 Birds. No toxicity information was available for benzene toxicity to birds. A qualitative discussion and comparison of mammalian and avian toxicity values is presented in Section 3.4.3, Risk Characterization.

3.3.2.4 Mammals. Nawrot and Staples (1979 in Opresko et al. 1994) reported a chronic reproductive LOAEL for laboratory mice orally exposed to benzene as 263.6 mg/kg. Using an uncertainty factor of 0.1, Opresko et al. (1994) convert the LOAEL to a chronic NOAEL for mice of 26.36 mg/kg. This is the value used to calculate the benzene TRV for mammals.

3.3.3 Toluene

Toluene, identified as a COC in soil/sediment at the Oliktok Point sites, is an alkylbenzene. It is a common constituent of petroleum products (ATSDR 1993a). Toluene toxicity in animals is commonly manifest as depression of the central nervous system (Klaasen et al. 1986). A summary of the relevant toxicity information is presented below.

3.3.3.1 Plants. No information was available concerning the toxicity of toluene to plants. A qualitative discussion of the toxicity of VOCs to plants in general is presented in Section 3.4.1, Risk Characterization.

3.3.3.2 Aquatic Organisms. Toluene was not selected as a COC in surface water and as a result, no aquatic toxicity information is presented.

3.3.3.3 Birds. No toxicity information was available for toluene toxicity to birds. A qualitative discussion and comparison of mammalian and avian toxicity values is presented in Section 3.4.3, Risk Characterization.

3.3.3.4 Mammals. Nawrot and Staples (1979 in Opresko et al. 1994) reported a chronic reproductive LOAEL for laboratory mice orally exposed to toluene of 259.8 mg/kg. Using an Uncertainty Factor of 0.1, Opresko et al. (1994) convert the LOAEL to a chronic NOAEL for mice of 25.98 mg/kg. This is the value used to calculate the toluene TRV for mammals.

3.3.4 Ethylbenzene

Ethylbenzene is a COC in soil and/or sediment at the Oliktok Point sites. It is a VOC, and most toxicity information in the literature relates to its inhalation. A summary of the relevant toxicity information is presented below.

3.3.4.1 Plants. In a cell multiplication inhibition test using *Microcystis aeruginosa* (algae) the toxicity threshold of ethylbenzene was 33,000 µg/L. The toxicity threshold of *Scenedesmus quadiracauda* (green algae) to ethylbenzene was >160,000 µg/L (Verschueren 1983). Galassi et al. (1988 in AQUIRE 1994) reported an EC_{50} [effective concentration for 50 percent of the organisms (growth)] of 4,600 µg/L for *Selanstrum capricornutum* (green algae).

3.3.4.2 Aquatic Organisms. Ethylbenzene was a COC in soil/sediment but not in water. As a result, no quantitative presentation of water exposure was conducted in this ERA.

3.3.4.3 Birds. There is no information in the literature regarding the toxicity of ethylbenzene to birds. A qualitative discussion and comparison of mammalian and avian toxicity is presented in Section 3.4.3, Risk Characterization.

3.3.4.4 Mammals. One study regarding the toxicity of ethylbenzene administered orally to rats reported an LD_{50} 5,460 mg/kg (Budavari 1989) (dose used to calculate TRV).

3.3.5 Xylenes

Xylenes are a COC in soil/sediment at the Oliktok Point sites. They are alkylbenzenes and common constituents of petroleum products (ATSDR 1993a). Most toxicity information in the literature relates to the inhalation of xylene. A summary of the relevant information is presented below.

3.3.5.1 Plants. In a study of the green algae, *Selenastrum capricornutum*, xylene decreased growth at concentrations of 72,000 µg/L (Gaur 1988 in AQUIRE 1990).

3.3.5.2 Aquatic Organisms. No aquatic toxicity information is presented because xylene was not identified as a COC in surface water.

3.3.5.3 Birds. When mallard eggs were immersed in xylene (1 percent and 10 percent) for 30 seconds, there was no significant effect on embryonic weight and length when compared to controls (Hoffman and Eastin 1981 in HSDB 1994). Japanese quail (*Coturnix japonica*) fed xylene demonstrated no sign of toxicity up to 5,000 ppm (Hill and Camardese 1986). The LC_{50} was >20,000 ppm (USFWS 1986). Hill and Camardese (1986) report a maximum dietary exposure level for Japanese quail of 608 mg/kg total xylenes (dose used to calculate TRV).

3.3.5.4 Mammals. Ingestion of xylene in mammals may cause prenatal mortality, growth inhibition, and malformations, primarily cleft palate. The LD_{50} for ingestion of xylene (rat) was reported as 4,300 mg/kg (Clayton and Clayton 1981) (dose used to calculate TRV).

3.3.6 Benzyl Alcohol

Benzyl alcohol was identified as a COC in soil/sediment at the Oliktok sites. Toxicity information is extremely limited for this chemical and the available information is presented below.

3.3.6.1 Plants. No toxicity information was available concerning plants and benzyl alcohol.

3.3.6.2 Aquatic Organisms. Benzyl alcohol was not identified as a COC in surface water, and as a result, no aquatic toxicity information is presented for benzyl alcohol.

3.3.6.3 Birds. No avian toxicity information for benzyl alcohol was available in the literature, but a qualitative evaluation of avian species may be made using inter-taxa toxicity standards (i.e., using mammalian toxicity values to evaluate avian species). A discussion of avian and mammalian comparative levels of toxicity is presented in Section 3.4.3, Risk Characterization.

3.3.6.4 Mammals. Sax and Lewis (1989) report an oral LD_{50} for rats exposed to benzyl alcohol of 1,230 mg/kg. This is the dose used to calculate the TRV.

3.3.7 Polychlorinated Biphenyls (PCBs)

PCBs were determined to be COCs in soil/sediment at the Oliktok Point installation. PCBs are organic compounds commercially produced through the chlorination of a biphenyl molecule (Eisler 1986). Depending upon the chlorination, ten possible congener groups exist. Within the congener groups a number of different isomers exist, each with varying toxicity. The specific PCB isomer detected at the Oliktok Point installation was Aroclor 1254. PCBs are very stable in the environment, slow to degrade, and are bioaccumulative. The following sections summarize the toxicity of PCBs.

3.3.7.1 Plants. Very little toxicity information for plants is available in the literature. However, PCBs may inhibit photosynthesis and cell motility in phytoplankton (Eisler 1986). In addition, aquatic plants may provide a route of exposure into the aquatic food chain. An increase (five times) in somatic mutations was noted in terrestrial plants growing on sediments containing mean PCB residues of 26 mg/kg (predominantly Aroclor 1254) (Eisler 1986).

3.3.7.2 Aquatic Organisms. PCBs were not found to be a COC in water so they are not quantitatively evaluated in terms of exposure of aquatic organisms.

3.3.7.3 Birds. PCBs are expected to disrupt patterns of growth, reproduction, metabolism, and behavior in sensitive avian species (Eisler 1986). Mourning doves (*Zenaida macroura carolinensis*) that were fed Aroclor 1254 for six weeks exhibited abnormal courtship behavior and reproductive effort. The tested concentrations were 10 or 40 ppm. The researchers suggested that the disrupted reproductive behavior was due to reduced hormone levels (Tori and Peterle 1983 in Eisler 1986). No reproductive efforts were observed in mallards (*Anas playrhynchos*) exposed to 150 ppm (mg/kg feed) Aroclor 1252 in the diet for 12 weeks during egg laying (Haseltine and Prouty 1980), or in mallards exposed to 25 ppm Aroclor 1254 in the diet for at least a month before egg laying (Custer and Heinz 1980 in Eisler 1986).

3.3.7.4 Mammals. Reproductive toxicity following chronic or subchronic exposures appears to be the most sensitive toxic endpoint of PCBs exposure in mammals. Mink (*Mustela vision*) are particularly susceptible to PCBs' reproductive effects. Mink fed contaminated beef (Aroclor 1254) developed reproductive complications at dietary residue levels as low as 0.64 ppm (Platanow and Karstad 1973). A dietary level LC_{50} of 6.7 ppm was reported for an exposure period of nine months for Aroclor 1254 (Ringer 1983). Other species may be less sensitive to PCBs' toxic effects. White-footed mice (*Peromyscus leucopus)* exposed to PCBs at a concentration of 10 ppm in the diet through the second generation exhibited poor reproductive success, growth, and development of organs, but no increased mortality (Linzey 1988).

3.3.8 Lead

Lead was found to be a COC in soil/sediment, but not in surface water. Lead is a trace element naturally found in environmental media (e.g., soil, water, etc,); however, it is neither essential nor beneficial to living organisms (Eisler 1988).

3.3.8.1 Plants. Lead inhibits plant growth, and reduces photosynthesis, mitosis, and water absorption (Eisler 1988). Concentrations of 500 mg/kg in soils were found to result in reduced pollen germination in several weed species, but the same study found that 46 mg/kg lead concentrations in soil did not have adverse effects on pollen germination (USACOE 1991).

3.3.8.2 Aquatic Organisms. Lead was not found to be a COC in surface water. As a result, aquatic organisms are not evaluated quantitatively for lead exposure in the ERA.

3.3.8.3 Birds. The bulk of the toxicity information in the literature regarding avian exposure to lead concerns waterfowl that have ingested spent lead shot and died. These results are reported as body burdens of lead. There is, however, limited dose-response information available for some species. Mautino and Bell (1987) reported neurological effects in mallard ducks that had ingested and absorbed lead shot for a total intake of 423.8 mg/kg body weight. Young American kestrels (*Falco sparverius*) (one-day old) that ingested 125 and 625 mg/kg body weight of lead, showed significantly depressed growth and hematocrit values (Hoffman et al. 1985). Damron et al. (1969 in NAS 1980) report a NOAEL of 100 ppm for lead in a 28-day toxicity study using four-week old chickens as the test organism. This is the dose used to calculate the TRV.

3.3.8.4 Mammals. Lead may affect the survival, growth, development, and metabolism of animal species. Rats are affected by 5 to 108 mg/kg body weight (acute oral dose); dogs by 0.32 mg/kg body weight daily (chronic oral dose); and horses by chronic dietary concentrations of 1.7 mg/kg (Eisler 1988). Azar et al. (1973 in Opresko et al. 1994) reports an oral dose of 8.0 mg/kg-bw/day to be a chronic NOAEL for laboratory rats (dose used to calculate TRV for brown lemming and arctic fox). Fick et al. (1976 in NAS 1980) report a chronic NOAEL for sheep of 10 ppm in diet. This value is used to calculate the TRV for caribou.

3.3.9 Manganese

Manganese was determined to be a COC in surface water. Manganese is considered to be an essential nutrient for animals (ATSDR 1990b), and it is important for growth and reproduction. The toxicity of manganese can be affected by pH and water hardness, although these interactions were not analyzed for the Oliktok Point sites. Available information for manganese is summarized below.

3.3.9.1 Plants. In a four-day study conducted using duckweed (*Lemna minor*), an EC_{50} (reduction in growth) of 31,000 μg/L was reported (Wang 1986 in AQUIRE 1990). Lewis et al. (1979) studied the species composition of freshwater phytoplankton populations when exposed to manganese. Population composition was altered at 0.1 mg/L manganese. Soil concentrations

of 1,500 to 3,000 mg/kg were reported as phytotoxic to all plant species (Kabata-Pendias and Pendias 1984).

3.3.9.2 Aquatic Organisms. Suter and Mabrey (1994) report lowest chronic screening benchmarks for fathead minnow and *Daphnia* spp. as 1,770 and 1,100 µg/L, respectively. These values are used to establish the aquatic TRVs for manganese.

3.3.9.3 Birds. Vohra and Kratzer (1968 in NAS 1980) exposed young turkeys to dietary manganese for 21 days. A NOEL of 4,080 ppm was derived. The maximum tolerable levels of manganese that are recommended by the NAS are 2,000 ppm (250 mg/kg body weight) for poultry. This is the value used to calculate the avian TRV.

3.3.9.4 Mammals. When fed 9,000 ppm manganese, sheep demonstrated reduced feed intake (Puls 1988). NAS (1980) recommends maximum tolerable levels of 1,000 ppm for cattle (15 mg/kg body weight) and sheep (40 mg/kg body weight). The value for sheep is used to calculate the TRV for caribou. A NOAEL of 930 mg/kg-bw/day is reported for rats in ATSDR (1990). The TRVs for brown lemming and arctic fox are based on the 930 mg/kg dose.

3.3.10 Characterization of Effects

In this section toxicity information is presented for representative ecological receptors evaluated in the risk characterization (Section 3.4). Potential impacts to aquatic receptors are evaluated by comparing exposure concentrations to TRVs. TRVs for the representative aquatic species are presented in Table 3-16. Potential impacts to terrestrial wildlife are evaluated for the representative species based on comparisons of estimated exposures to TRVs. Exposure to COCs for the representative terrestrial species is primarily through diet, which may include plants, fish, aquatic invertebrates, soils, and surface water. TRVs are derived for COCs in surface water and soil/sediment. TRVs for the representative and sensitive bird species are presented in Table 3-17, and for the representative mammal species in Table 3-18.

3.3.10.1 Toxicity Reference Values. TRVs are derived by selecting toxicity values from the literature and extrapolating to the species of concern. Uncertainty factors (UF) and body scaling factors are used in the extrapolation process as described below.

(1) The first step is to select an appropriate toxicity value from the scientific literature for each combination of chemical and representative or protected species. Test species most similar to the species of concern are preferred. A secondary emphasis is given to tests conducted over a significant portion of the animal's natural lifespan (i.e., chronic tests) when available.

(2) The second step is to modify the toxicity value, if necessary, through application of uncertainty factors associated with the quality of toxicity data to derive a NOAEL (the highest concentration of a material in a toxicity test that has no statistically significant adverse effect on the exposed population of test organisms as compared with the next highest dose tested). If a chronic NOAEL or No Observed Effect Level (NOEL) is available, it is used with an uncertainty factor of one (i.e., no adjustment) because these

TABLE 3-16. TOXICITY REFERENCE VALUES FOR REPRESENTATIVE SPECIES OF AQUATIC ORGANISMS AT THE OLIKTOK POINT INSTALLATION

CHEMICAL OF CONCERN	REPRESENTATIVE SPECIES	STUDY TYPE	CONCENTRATION (μg/L)	TEST SPECIES	NOAEL UF	INTERSPECIES UF	PROTECTED SPECIES UF	TRV (μg/L)	REFERENCE
DRPH	nine-spined stickleback	LC_{50}	38,600	fathead minnow	20	2	1	965	Hedtke and Puglisis 1982
DRPH	*Daphnia* spp.	LOAEL	5,600	*D. pulex*	20	1	1	280	Hedtke and Puglisis 1982

* Toxicity information shown is for DRPH; no data available for GRPH.

TABLE 3-17. TOXICITY REFERENCE VALUES FOR REPRESENTATIVE AND SENSITIVE SPECIES OF BIRDS AT THE OLIKTOK POINT INSTALLATION

CHEMICAL OF CONCERN	REPRESENTATIVE SPECIES	STUDY TYPE	DOSE mg/kg-bw/day	TEST SPECIES	NOAEL UF	SCALING FACTOR	INTERSPECIES UF	PROTECTED SPECIES UF	TRV mg/kg-bw/day	REFERENCE
DRPH	Lapland longspur	Decreased weight gain LOAEL	6,000	mallard	10	0.29	2	2	517	Hartung 1964
	Brant	Decreased weight gain LOAEL	6,000	mallard	10	1.07	2	2	140	Hartung 1964
	Glaucous gull	Decreased weight gain LOAEL	6,000	mallard	10	1.10	2	2	136	Hartung 1964
	Pectoral sandpiper	Decreased weight gain LOAEL	6,000	mallard	10	0.42	2	2	357	Hartung 1964
	Spectacled eider	Decreased weight gain LOAEL	6,000	mallard	10	1.08	2	2	139	Hartung 1964
GRPH	No avian data available for GRPH; defer to DRPH data as surrogate toxicity information.									
Benzene	No avian toxicity data available for benzene; see discussion in Section 3.4.3, Potential Risks to Representative Species of Birds.									
Toluene	No avian toxicity data available for toluene, see discussion in Section 3.4.3, Potential Risks to Representative Species of Birds.									
Ethylbenzene	No avian toxicity data available for ethylbenzene, see discussion in Section 3.4.3, Potential Risks to Representative Species of Birds.									
Xylene	Lapland longspur	Maximum dietary exposure	608	Japanese quail	10	0.60	2	2	25	Hill and Camardese 1986
	Brant	Maximum dietary exposure	608	Japanese quail	10	2.16	2	2	7	Hill and Camardese 1986
	Glaucous gull	Maximum dietary exposure	608	Japanese quail	10	2.23	2	2	7	Hill and Camardese 1986
	Pectoral sandpiper	Maximum dietary exposure	608	Japanese quail	10	0.85	2	2	18	Hill and Camardese 1986

TABLE 3-17. TOXICITY REFERENCE VALUES FOR REPRESENTATIVE AND SENSITIVE SPECIES OF BIRDS AT THE OLIKTOK POINT INSTALLATION (CONTINUED)

CHEMICAL OF CONCERN	REPRESENTATIVE SPECIES	STUDY TYPE	DOSE mg/kg-bw/day	TEST SPECIES	NOAEL UF	SCALING FACTOR	INTERSPECIES UF	PROTECTED SPECIES UF	TRV mg/kg-bw/day	REFERENCE
Xylene (Continued)	Spectacled eider	Maximum dietary exposure	608	Japanese quail	10	2.39	2	2	6	Hill and Camardese 1986
Benzyl alcohol	No avian toxicity data available for benzyl alcohol; see discussion in Section 3.4.3, Potential Risks to Representative Species of Birds.									
PCBs	Lapland longspur	LD_{50}	2,699	mallard	20	0.29	2	2	116	Heath et al. 1972
	Brant	LD_{50}	2,699	mallard	20	1.07	2	2	32	Heath et al. 1972
	Glaucous gull	LD_{50}	2,699	mallard	20	1.1	2	2	31	Heath et al. 1972
	Pectoral sandpiper	LD_{50}	2,699	mallard	20	0.42	2	2	80	Heath et al. 1972
	Spectacled eider	LD_{50}	2,699	mallard	20	1.08	2	2	31	Heath et al. 1972
Lead	Lapland longspur	NOAEL; 4 week old chicks 28 day study	17.5	chicken	1	0.32	2	2	14	Damron et al. 1969 in NAS 1980
	Brant	NOAEL; 4 week old chicks 28 day study	17.5	chicken	1	1.18	2	2	3.7	Damron et al. 1969 in NAS 1980
	Glaucous gull	NOAEL; 4 week old chicks 28 day study	17.5	chicken	1	1.22	2	2	3.5	Damron et al. 1969 in NAS 1980

TABLE 3-17. TOXICITY REFERENCE VALUES FOR REPRESENTATIVE AND SENSITIVE SPECIES OF BIRDS AT THE OLIKTOK POINT INSTALLATION (CONTINUED)

CHEMICAL OF CONCERN	REPRESENTATIVE SPECIES	STUDY TYPE	DOSE mg/kg-bw/day	TEST SPECIES	NOAEL UF	SCALING FACTOR	INTERSPECIES UF	PROTECTED SPECIES UF	TRV mg/kg-bw/day	REFERENCE
Lead (Continued)	Pectoral sandpiper	NOAEL; 4 week old chicks 28 day study	17.5	chicken	1	0.46	2	2	9.5	Damron et al. 1969 in NAS 1980
	Spectacled eider	NOAEL; 4 week old chicks 28 day study	17.5	chicken	1	1.20	2	2	3.7	Damron et al. 1969 in NAS 1980
Manganese	Lapland longspur	Systemic LOAEL	250	chicken	10	0.32	2	2	19.5	NAS 1980
	Brant	Systemic LOAEL	250	chicken	10	1.18	2	2	5.3	NAS 1980
	Glaucous gull	Systemic LOAEL	250	chicken	10	1.22	2	2	5.1	NAS 1980
	Pectoral sandpiper	Systemic LOAEL	250	chicken	10	0.46	2	2	13.6	NAS 1980
	Spectacled eider	Systemic LOAEL	250	chicken	10	1.20	2	2	5.2	NAS 1980

TABLE 3-18. TOXICITY REFERENCE VALUES FOR REPRESENTATIVE SPECIES OF MAMMALS AT THE OLIKTOK POINT INSTALLATION

CHEMICAL OF CONCERN	REPRESENTATIVE SPECIES	STUDY TYPE	DOSE mg/kg-bw/day	TEST SPECIES	NOAEL UF	SCALING FACTOR	INTERSPECIES UF	PROTECTED SPECIES UF	TRV mg/kg-bw/day	REFERENCE
DRPH	Brown lemming	LD_{50}	7,380	rat	20	0.60	2	1	308	Beck et al. 1982
	Arctic fox	LD_{50}	7,380	rat	20	2.70	2	1	68	Beck et al. 1982
	Caribou	LD_{50}	7,380	rat	20	7.24	2	1	25	Beck et al. 1982
GRPH	Brown lemming	Subchronic renal effects NOAEL	500	rat	10	0.60	2	1	2	ATSDR 1993b
	Arctic fox	Subchronic renal effects NOAEL	500	rat	10	2.70	2	1	9	ATSDR 1993b
	Caribou	Subchronic renal effects NOAEL	500	rat	10	7.24	2	1	3	ATSDR 1993b
Benzene	Brown lemming	Reproductive NOAEL	26.36	mouse	1	1.30	2	1	10	Nawrot and Staples 1979 in Opresko et al. 1994
	Arctic fox	Reproductive NOAEL	26.36	mouse	1	5.82	2	1	2	Nawrot and Staples 1979 in Opresko et al. 1994
	Caribou	Reproductive NOAEL	26.36	mouse	1	15.59	2	1	1	Nawrot and Staples 1979 in Opresko et al. 1994
Toluene	Brown lemming	Reproductive NOAEL	25.98	mouse	1	1.30	2	1	10	Nawrot and Staples 1979 in Opresko et al. 1994
	Arctic fox	Reproductive NOAEL	25.98	mouse	1	5.82	2	1	2	Nawrot and Staples 1979 in Opresko et al. 1994

TABLE 3-18. TOXICITY REFERENCE VALUES FOR REPRESENTATIVE SPECIES OF MAMMALS AT THE OLIKTOK POINT INSTALLATION (CONTINUED)

CHEMICAL OF CONCERN	REPRESENTATIVE SPECIES	STUDY TYPE	DOSE mg/kg-bw/day	TEST SPECIES	NOAEL UF	SCALING FACTOR	INTERSPECIES UF	PROTECTED SPECIES UF	TRV mg/kg-bw/day	REFERENCE
Toluene (Continued)	Caribou	Reproductive NOAEL	25.98	mouse	1	15.59	2	1	1	Nawrot and Staples 1979 in Opresko et al. 1994
Ethylbenzene	Brown lemming	LD_{50}	5,450	rat	20	0.60	2	1	228	Budavari 1989
	Arctic fox	LD_{50}	5,460	rat	20	2.70	2	1	51	Budavari 1989
	Caribou	LD_{50}	5,460	rat	20	7.24	2	1	19	Budavari 1989
Xylenes (total)	Brown lemming	LD_{50}	4,300	rat	20	0.60	2	1	179	Clayton and Clayton 1981
	Arctic fox	LD_{50}	4,300	rat	20	2.70	2	1	40	Clayton and Clayton 1981
	Caribou	LD_{50}	4,300	rat	20	7.24	2	1	15	Clayton and Clayton 1981
Benzyl alcohol	Brown lemming	LD_{50}	1,230	rat	20	0.60	2	1	51	Sax and Lewis 1989
	Arctic fox	LD_{50}	1,230	rat	20	2.70	2	1	11	Sax and Lewis 1989
	Caribou	LD_{50}	1,230	rat	20	7.24	2	1	4	Sax and Lewis 1989
PCBs (Aroclor 1254)	Brown lemming	LD_{50}	75	rat	20	0.60	2	1	3.1	Hudson et al. 1984
	Arctic fox	LD_{50}	75	rat	20	2.70	2	1	0.7	Hudson et al. 1984
	Caribou	LD_{50}	75	rat	20	7.24	2	1	0.3	Hudson et al. 1984

TABLE 3-18. TOXICITY REFERENCE VALUES FOR REPRESENTATIVE SPECIES OF MAMMALS AT THE OLIKTOK POINT INSTALLATION (CONTINUED)

CHEMICAL OF CONCERN	REPRESENTATIVE SPECIES	STUDY TYPE	DOSE mg/kg-bw/day	TEST SPECIES	NOAEL UF	SCALING FACTOR	INTERSPECIES UF	PROTECTED SPECIES UF	TRV mg/kg-bw/day	REFERENCE
Lead	Brown lemming	Chronic NOAEL, three generation reproductive study	8	rat	1	0.60	2	1	6.7	Azar et al. 1973 in Opresko et al. 1994
	Arctic fox	Chronic NOAEL, three generation reproductive study	8	rat	1	2.70	2	1	1.5	Azar et al. 1973 in Opresko et al. 1994
	Caribou	Chronic NOAEL, three generation reproductive study	0.4	sheep	1	1.17	2	1	0.17	Fick et al. 1976 in NAS 1980
Manganese	Brown lemming	Chronic systemic NOAEL	930	rat	1	0.60	2	1	780	Hejtmanick et al. 1987 in ATSDR 1990
	Arctic fox	Chronic systemic NOAEL	930	rat	1	2.70	2	1	170	Hejtmanick et al. 1987 in ATSDR 1990
	Caribou	Maximum tolerable dietary level NOAEL	40	sheep	1	1.17	2	1	17	NAS 1980

values have the lowest uncertainty. If chronic data are unavailable, acute or subchronic toxicity data are modified by uncertainty factors to extrapolate to chronic effects. Based on Harding Lawson Associates (1992), the following strategy was derived for uncertainty factors for extrapolating study results to chronic NOAELs: 10 for chronic low observed effect level (LOEL) values, 10 for subchronic NOEL values, and 20 for subchronic LOEL values. LC_{50} and LD_{50} values are extrapolated to chronic NOAELs by a factor of 20.

(3) The third step is applicable only to terrestrial receptors. This step extrapolates the estimated NOAEL from the test species to a NOAEL for the species of concern using a body scaling factor. Klaassen et al. (1986) have indicated that dose expressed per unit surface area may be more appropriate than dose per unit body weight. The underlying assumption is that a toxicant acts on a physiologic surface and that the toxic effect increases as the ratio of chemical to surface area increases. The scaling factor (SF) accounts for differences in the mass to surface area ratios between species. In this assessment the scaling factor is calculated using the following equation (Mantel and Schneiderman 1975) (scaling factors are presented in Appendix F):

$$SF = (\text{weight of representative species/weight of test species})^{1/3}$$

(4) An uncertainty factor of two is used to account for interspecies variation in sensitivity. This value is based on the methodology used in Harding Lawson Associates (1992).

(5) An uncertainty factor of two was used to account for additional sensitivity of state and/or federally protected species. This value is based on Harding Lawson Associates (1992). Migratory birds are federally protected and include all the representative avian and protected species selected for this assessment.

The methods of calculating the TRV for the terrestrial and aquatic receptors are as follows:

TERRESTRIAL:

a) Convert test dose to a NOAEL:
DOSE 1 ÷ **NOAEL UF** = Estimated NOAEL

b) Adjust for body size difference between test species and ROC:
Estimated NOAEL ÷ **SCALING FACTOR** = Scaled, estimated NOAEL

c) Adjust for interspecific differences:
Scaled, estimated NOAEL ÷ **INTERSPECIES UF** = Species-specific, scaled, estimated NOAEL.

d) Account for protected species status:
Species-specific, scaled, estimated NOAEL ÷ **PROTECTED SPECIES UF** = **TRV**

AQUATIC:
EFFECTIVE CONCENTRATION ÷ **NOAEL UF** ÷ **INTERSPECIES UF** = **TRV**

3.4 RISK CHARACTERIZATION FOR ECOLOGICAL RECEPTORS

Hazard quotients (HQs) for the representative species are presented in this section. Potential risks to plants are evaluated based on the contaminant concentrations in the soil/sediment and information from the literature. Potential risks to aquatic organisms, birds, and mammals are estimated by comparing estimated exposures to TRVs (i.e., quotient method). The quotient method divides the estimated exposure concentration by the associated TRV to derive the HQ. If the HQ is less than 1.0, adverse effects are not expected. Conversely, if the HQ is equal to, or greater than, 1.0, a potential for adverse effects exists. The confidence level of the risk estimate is increased as the magnitude of the HQ departs from 1.0. For example, there is greater confidence in a risk estimate where the HQ is 0.1 or 10, than in a HQ such as 0.9 or 1.1. The confidence level is also dependent on the uncertainty associated with the estimated exposure and the TRV for a given chemical-receptor combination.

The characterization of risk focuses on the assessment endpoints. These endpoints are selected and discussed in keeping with the Framework for Ecological Risk Assessment guidance (EPA 1992a). The assessment endpoints for the Oliktok Point ERA are changes in:

- The populations of the plant representative species (*Carex* spp., *Salix* spp., *Eriophorum* spp., and *Vaccinium* spp.);
- The populations of aquatic representative species (*Daphnia* spp. and nine-spined stickleback);
- The populations of avian representative and sensitive species (Lapland longspur, brant, glaucous gull, pectoral sandpiper, and spectacled eider); and
- The populations of mammalian representative species (brown lemming, arctic fox, and barren-ground caribou).

The measurement endpoints used to evaluate potential changes in populations of the representative species were based on the endpoints used to derive the TRVs. These endpoints included physiological effects, growth, reproduction, and mortality.

Potential ecological risks to representative species are presented in the following sections: Section 3.4.1 addresses plants; Section 3.4.2 considers aquatic organisms; Section 3.4.3 addresses birds; and Section 3.4.4 discusses mammals. A discussion of potential future risks to ecological receptors is presented in Section 3.4.5. Toxicity information and the HQs that represent potential risk estimates are summarized in the tables presented within these sections.

3.4.1 Potential Risks to Representative Species of Plants

In determining the risks to plants at the Oliktok Point sites, a qualitative comparison was made of soil and surface water contaminant concentrations and plant toxicity information in the literature. Table 3-19 summarizes these comparisons. There is a great deal of uncertainty in this phase of the assessment because of the differences in degree of uptake between plant species

TABLE 3-19. COMPARISON OF COC CONCENTRATIONS TO TOXICITY INFORMATION FOR PLANTS AT THE OLIKTOK POINT INSTALLATION

CHEMICAL (COC media)	PLANT	EXPOSURE LEVEL	EFFECT ON PLANT	OLIKTOK POINT EXPOSURE	REFERENCE
VOCs (COCs as DRPH and GRPH in water; as DRPH, GRPH, benzene, toluene, ethylbenzene, and xylene, and benzyl alcohol in soil/sediment)	Green algae	4,600 µg/L for ethylbenzene 2,290 µg/L for methylene chloride in water.	EC_{50}	DRPH = 520 µg/L GRPH = 38 µg/L DRPH = 8,100 mg/kg GRPH = 170 mg/kg Benzene = 0.44 mg/kg toluene = 0.62 mg/kg ethylbenzene = 1.7 mg/kg xylenes = 3.0 mg/kg	USACOE 1991
PCBs (Aroclor 1254) (COC in soil/sediment)	Pigweed	40 mg/kg 20 mg./kg	22% weight reduction NOAEL	0.40 mg/kg as 1254	Strek and Weber 1982 in Will and Suter 1994
Lead (COC in soil/sediment)	Weed spp.	500 mg/kg in soil	Reduced pollen germination	18 mg/kg	USACOE 1991
	Weed spp.	46 mg/kg	Normal germination	18 mg/kg	USACOE 1991
Manganese (COC in soil)	Terrestrial plants	1,500 - 3,000 mg/kg	Phytotoxic	290 mg/kg	Kabata-Pendias and Pendias 1984

(Walker et al. 1978); however, the concentrations of contaminants onsite can be compared on the level of orders of magnitude, which can identify broad trends and determine whether a potential risk may exist.

Generally, information is limited concerning the toxicity of the COCs at Oliktok Point and how they relate to the representative species of plants. As a result, when comparisons of TRVs for site-specific species and chemicals are not possible, comparisons of related chemicals with other plant species are made.

As seen in Table 3-19, the risk posed to plants by COCs in surface water (DRPH and GRPH) is not expected to be significant because the concentrations of VOCs in soil/sediment are below the reported toxicity values. In addition, the risk presented by VOCs in soil/sediment, with the exception of DRPH, is also likely to be insignificant. Toxicity values for DRPH and vascular plants were not available in the literature, but VOCs are not expected to be present at significant levels in most plants because of their volatility, absorption to soil particles, metabolism, or degradation rates in soil (Kostecki and Calabrese 1989). PCBs were COCs in soil/sediment at the Oliktok Point installation. As shown in Table 3-19, however, the concentration in soils is well below the phytotoxic level. The risk to plants from PCBs is likely to be low, but PCBs are known to bioaccumulate. The potential for PCBs to bioaccumulate is addressed in Section 3.4.5. The potential risk from lead and manganese to plants at Oliktok Point is also likely to be low given that the exposure concentration is substantially less than the level known to induce a toxic response (Table 3-19).

3.4.2 Potential Risks to Representative Species of Aquatic Organisms

Estimates of exposure for aquatic organisms are based on the average concentrations of each COC in surface water samples (Section 3.1). The HQs for aquatic organisms are presented in Table 3-20. The HQs are calculated by dividing the estimated exposure concentration by the TRV. The following paragraph summarizes the potential risks to aquatic organisms from DRPH and GRPH, the COCs identified in surface water.

The HQs for DRPH in surface water were slightly above 1.0 for *Daphnia* spp., but were below 1.0 for the nine-spined stickleback. These HQs indicate that a slight risk may exist for *Daphnia* spp.; however, given that the HQ was only slightly higher than the benchmark of 1.0, it is unlikely that the potential risk could present a threat to the *Daphnia* spp. population. GRPH were evaluated using toxicity data for DRPH because toxicity data for GRPH were not available for aquatic organisms. The chemicals that drive the toxicity of DRPH are often the same as those found in GRPH. DRPH were found at higher concentrations than GRPH in surface water (520 μg/L vs. 38 μg/L), so the risk to aquatic organisms is conservatively calculated by examining DRPH.

It should be noted that two surface water samples (one sample and a duplicate) were not included in the risk assessment (see Sections 3.1.1.2, Metals). This was because the sample results were anomalous. Concentrations of TSS were highly elevated. Elevated concentrations of TSS could contribute to the exhibited elevation of total metals in comparison to dissolved metals in these samples. Typically, the toxicity of metals in surface water is determined by the dissolved fraction (Rand and Petrocelli 1985). Because the dissolved fraction of metals in these

TABLE 3-20. HAZARD QUOTIENTS FOR REPRESENTATIVE SPECIES OF AQUATIC ORGANISMS AT THE OLIKTOK POINT INSTALLATION

SPECIES	ESTIMATED EXPOSURE CONCENTRATION (μg/liter)	TRV (μg/liter)	HAZARD QUOTIENT
DRPH			
Daphnia spp.	520	280	2
nine-spined stickleback	520	965	0.5

samples were non-detects or within background or "normal" levels, these samples were not included in the risk assessment. In addition, the sample location is at the end of a discharge pipe at the Old Sewage Area Petroleum Spill. At the time the samples were collected, there was no standing water at this location. In order to obtain a water sample, the sampling crew dug a small hole in the depression in the soil at the end of the pipe. The hole was allowed to stand and water seeped in from the surrounding damp soils. As a result, the TSS levels and associated total metal concentrations were quite high. More importantly, this sampling location does not provide a complete surface water exposure pathway for either aquatic or terrestrial receptors. As a result, there is no risk associated with these two surface water samples.

3.4.3 Potential Risks to Representative Species of Birds

The avian (and mammalian) HQs are presented in Table 3-21. The HQs for the avian representative species were less than 1.0 for all the COCs that were quantified. HQs were not calculated for GRPH, benzene, toluene, ethylbenzene, or benzyl alcohol because no toxicity information was available for avian species; however, a discussion of the relative toxicity of these chemicals provides a basis for making qualitative statements concerning their toxicity to avian species. Smith (1987) provides the following ranking of relative toxicities based on median lethal doses (LD_{50}s).

I. Extremely toxic (LD_{50} ≤40 mg/kg)
II. Highly toxic (LD_{50} 41-200 mg/kg)
III. Moderately toxic (LD_{50} 201-1,000 mg/kg)
IV. Slightly toxic (LD_{50} 1,001-5,000 mg/kg)
V. Relatively nontoxic (LD_{50} >5,000 mg/kg)

Table 3-22 shows the relative toxicity rankings of GRPH, benzene, toluene, ethylbenzene, and benzyl alcohol based on Smith (1987).

Using the relative toxicities of these COCs, the exposure estimates for avian and mammalian species, and the HQs that were calculated for mammalian species (see Table 3-21 for exposure estimates and HQs), it is possible to make inferences concerning the potential risk to avian species.

TABLE 3-21. HAZARD QUOTIENTS FOR REPRESENTATIVE BIRDS AND MAMMALS AT THE OLIKTOK POINT INSTALLATION

CHEMICAL OF CONCERN	ESTIMATED EXPOSURE (mg/kg-bw/day)	TRV (mg/kg-bw/day)	HAZARD QUOTIENT
DRPH			
Lapland longspur	2.8E+01	517	5E-02
Brant	1.8E+01	140	1E-01
Glaucous gull	2.0E+00	136	1E-02
Pectoral sandpiper	2.1E+02	357	6E-01
Spectacled eider	7.6E-01	139	6E-03
Brown lemming	2.0E+02	308	7E-01
Arctic fox	2.4E-01	68	4E-03
Caribou	1.1E-01	25	4E-03
BENZENE			
Lapland longspur	3.2E-02	NA	NC
Brant	1.9E-02	NA	NC
Glaucous gull	4.1E-04	NA	NC
Pectoral sandpiper	2.5E-02	NA	NC
Spectacled eider	3.0E-04	NA	NC
Brown lemming	4.1E-01	10	4E-02
Arctic fox	1.3E-05	2	6E-06
Caribou	2.5E-04	1	3E-04
TOLUENE			
Lapland longspur	2.2E-02	NA	NC
Brant	1.3E-02	NA	NC
Glaucous gull	3.5E-04	NA	NC
Pectoral sandpiper	2.5E-02	NA	NC
Spectacled eider	2.3E-04	NA	NC
Brown lemming	2.8E-01	10	3E-02
Arctic fox	1.8E-05	2	9E-06
Caribou	1.7E-04	1	2E-04

TABLE 3-21. HAZARD QUOTIENTS FOR REPRESENTATIVE BIRDS AND MAMMALS AT THE OLIKTOK POINT INSTALLATION (CONTINUED)

CHEMICAL OF CONCERN	ESTIMATED EXPOSURE (mg/kg-bw/day)	TRV (mg/kg-bw/day)	HAZARD QUOTIENT
ETHYLBENZENE			
Lapland longspur	3.5E-02	NA	NC
Brant	2.1E-02	NA	NC
Glaucous gull	7.0E-04	NA	NC
Pectoral sandpiper	5.6E-02	NA	NC
Spectacled eider	4.0E-04	NA	NC
Brown lemming	4.3E-01	228	2E-03
Arctic fox	4.9E-05	51	1E-06
Caribou	2.6E-04	19	1E-05
XYLENES (TOTAL)			
Lapland longspur	9.6E-02	25	4E-03
Brant	5.8E-02	7	8E-03
Glaucous gull	1.6E-03	7	2E-04
Pectoral sandpiper	1.2E-01	18	6E-03
Spectacled eider	1.0E-03	6	2E-04
Brown lemming	1.2E+00	179	7E-03
Arctic fox	8.7E-05	40	2E-06
Caribou	7.5E-04	15	5E-05
BENZYL ALCOHOL			
Lapland longspur	2.8E-01	NA	NC
Brant	1.7E-01	NA	NC
Glaucous gull	3.0E-03	NA	NC
Pectoral sandpiper	1.5E-01	NA	NC
Spectacled eider	2.5E-03	NA	NC
Brown lemming	3.8E+00	51	7E-02
Arctic fox	2.6E-05	11	2E-06
Caribou	2.3E-03	4	6E-04

TABLE 3-21. HAZARD QUOTIENTS FOR REPRESENTATIVE BIRDS AND MAMMALS AT THE OLIKTOK POINT INSTALLATION (CONTINUED)

CHEMICAL OF CONCERN	ESTIMATED EXPOSURE (mg/kg-bw/day)	TRV (mg/kg-bw/day)	HAZARD QUOTIENT
PCBs			
Lapland longspur	1.2-03	116	1E-05
Brant	8.1E-04	32	3E-05
Glaucous gull	1.1E-04	31	4E-06
Pectoral sandpiper	1.2E-02	80	2E-04
Spectacled eider	4.1E-05	31	1E-06
Brown lemming	5.9E-03	3	2E-03
Arctic fox	1.4E-05	1	2E-05
Caribou	2.8E-06	0	9E-06
LEAD			
Lapland longspur	6.9E-02	14	5E-03
Brant	4.4E-02	4	1E-02
Glaucous gull	4.4E-03	4	1E-03
Pectoral sandpiper	4.6E-01	10	5E-02
Spectacled eider	1.8E-03	4	5E-04
Brown lemming	5.3E-01	7	8E-02
Arctic fox	5.2E-04	2	4E-04
Caribou	2.9E-04	0.2	2E-03
MANGANESE			
Lapland longspur	2.9E+00	20	2E-01
Brant	1.8E+00	5	4E-01
Glaucous gull	9.0E-02	5	2E-02
Pectoral sandpiper	8.3E+00	14	6E-01
Spectacled eider	4.4E-02	5	9E-03
Brown lemming	3.3E+01	780	4E-02
Arctic fox	8.4E-03	170	5E-05
Caribou	2.0E-02	17	1E-03

NA = Toxicity data are not available.
NC = Not Calculated.

TABLE 3-22. RELATIVE TOXICITY RANKINGS FOR COMPARISON OF MAMMALIAN AND AVIAN TOXICITY

COC	STUDY TYPE	DOSE (mg/kg/day)	RELATIVE TOXICITY
GRPH	Oral rat LD_{50}	14,063[a]	Relatively nontoxic
Benzene	Oral rat LD_{50}	3,400[b]	Slightly toxic
Toluene	Oral rat LD_{50}	5,000[b]	Slightly toxic
Ethylbenzene	Oral rat LD_{50}	5,460[b]	Relatively nontoxic
Benzyl alcohol	Oral rat LD_{50}	1,230[b]	Slightly toxic

a ATSDR 1993b.
b Sax and Lewis 1989.

There is limited information available on the relative toxicologic sensitivities of birds compared to mammals. Based upon a review of the species and chemicals tested (Smith 1987; Hudson et al. 1979; Tucker and Leitzke 1979), it appears in general that avian and mammalian sensitivities (via oral exposure) fall within the same range, with birds being slightly more sensitive than mammals. There are, of course, exceptions to this general observation and for a number of chemicals mammals are more sensitive than birds. For cases where birds are more sensitive, most avian toxicity values fall well within one order of magnitude of the mammalian toxicity values.

As noted, avian toxicity values are not available for some COCs in this ERA. However, based on the information presented above, these chemicals are not expected to be significantly more toxic to birds than to mammals. Birds are not expected to be at risk given that there are no HQs for the COCs above 1.0 for mammals, and the estimated exposures for birds are sufficiently lower than those for mammals to offset the possibility that some birds may be more sensitive than mammals to these selected COCs. This qualitative discussion and the inter-taxa toxicity estimates introduce additional elements of uncertainty to the risk assessment. See Section 3.5, Uncertainty Analysis, for more discussion of this topic.

Based on the above discussions and the HQs presented in Table 3-21, the risk estimates for the avian representative species at the Oliktok Point installation are not significant.

3.4.4 Potential Risks to Representative Species of Mammals

HQs for the brown lemming, arctic fox, and the barren-ground caribou are below 1.0 for all COCs. The estimated exposures, TRVs, and HQs are presented in Table 3-21. Based on the calculated HQs, the risk estimates for mammals at the Oliktok Point installation are not significant.

3.4.5 Potential Future Risks

Estimates of future risk at the Oliktok Point installation are based on the assumption that the gravel pads will remain in place and that the sites will remain suitable habitat for the representative species. Future risks related to all the COCs (with the exception of PCBs) at all of the potentially contaminated sites are expected to be as low as, or lower than, current risks (i.e., not significant) because the exposure pathways are not likely to change, and the concentrations of COCs are likely to diminish over time. Because soil/sediment samples indicate the presence of PCBs (Aroclor 1254) at the Old Landfill (LF01), Garage (SS10), and Old Sewage Area Petroleum Spill (SS11) sites, future risk estimates at these sites may be greater than the current estimates because of the high potential for PCBs to bioaccumulate.

PCBs have very high chemical, thermal, and biological stability in addition to low vapor pressure (Manahan 1994). Conversion of highly substituted PCBs to molecules with one or two chlorine is done relatively slowly by anaerobic bacteria (Manahan 1994). Therefore, natural biodegradation may not be an effective process for significantly reducing the PCBs to concentrations that are protective of the environment. In addition, PCBs have a high potential for bioaccumulation which may result in a magnification of PCB concentrations and resultant exposure to PCBs by ecological receptors through the food chain.

Risk estimates related to potential exposure to PCBs under current conditions at the Old Landfill, Garage, and Old Sewage Area Petroleum Spill sites are not significant. There is potential for all of these estimates to increase over time as potential pathways for PCB exposure may be completed. It is not possible to quantify the future risk estimate for PCBs, and the qualitative estimate can only state that the future risk is potentially greater than the current risk estimate. Given the limited areas where relatively low levels of PCBs were detected, the potential bioaccumulation and future risk are not likely to be significant.

3.5 ECOLOGICAL RISK ASSESSMENT UNCERTAINTY ANALYSIS

As with any risk assessment, there is great uncertainty associated with the estimates of ecological risk for the sites at the Oliktok Point installation. The risk estimates are based on a number of assumptions regarding exposure and toxicity. In general, the primary sources of uncertainty are the following:

- Environmental Sampling and Analysis;
- Selection of COCs;
- Selection of Representative Species;
- Exposure Parameter Estimation; and
- Toxicological Data.

A complete understanding of the uncertainties associated with risk estimates is critical to placing the predicted risks in proper perspective. The most significant sources of uncertainty associated with the estimates of risk for the Oliktok Point installation sites are summarized in the following sections.

3.5.1 Environmental Sampling and Analysis

The principal source of uncertainty in the analytical data (for the ERA) stems from the sampling approach and the subsequent calculation of exposure concentrations. Sampling at the Oliktok Point installation was conducted in a systematic manner, designed to characterize localized contaminated areas or "hot spots". Therefore, the average concentrations of COCs tend to be biased high because sampling was generally concentrated in areas of the installation where significant contamination exists or was suspected. In order to partially compensate for this non-random sampling methodology in the calculation of exposure concentrations, the exposure assessment used the average concentration of COCs across the site.

The methods of calculating the average concentrations were the same for organic and inorganic data. In calculating the average concentration of chemicals at the site, non-detected chemicals were entered at one-half of the quantitation limit, as per EPA guidance (EPA 1989a). The use of total metal concentrations in surface water to estimate risk is a conservative approach because dissolved metal concentrations are generally significantly less than total metal concentrations. Therefore, the average concentrations of total metals used to estimate exposure in surface water may overestimate potential risk.

In addition, the sample quantitation limits for several metals were higher than the action levels used to screen the chemicals. Therefore, non-detected concentrations of beryllium, cadmium, copper, chromium, lead, selenium, silver, and thallium may be present in quantities sufficient to elicit adverse effects in aquatic organisms. This probably contributes a low level of uncertainty to the overall risk estimate because surface water pathways at the Oliktok Point installation are not likely to be significant routes of exposure to representative species other than *Daphnia* spp.

There is uncertainty inherent in using measurements of petroleum hydrocarbon analyses (DRPH, GRPH, and RRPH) for risk assessments. The analytical techniques are not specific to petroleum (i.e., they detect other organics, including naturally-occurring ones) (Von Burg 1993). Moreover, the toxicity of these groups of petroleum hydrocarbons is determined by the toxicity of their individual constituents. When petroleum compounds are released to the environment, they tend to weather or transform readily. For example, the lighter fractions (such as BTEX) will volatilize to the atmosphere more readily than the heavier fractions (such as decane, pyrene, or benzo(a)pyrene). The lighter fractions are thought to be the more toxic (Wong et al. 1981; O'Brien 1978; Kauss and Hutchinson 1975; and Soto et al. 1975). Therefore, the toxicity of DRPH, GRPH, and RRPH is expected to change over time depending upon the attenuation mechanisms occurring in the environment. As a result, the toxicity of the petroleum hydrocarbons detected at the Oliktok Point sites is unknown. Use of toxicity values reported in the literature probably contributes to an overestimation of the risk because it is likely that the most toxic components of the mixtures detected have volatilized to the atmosphere over time.

3.5.2 Selection of Chemicals for Evaluation

The selection of COCs in the ERA was based upon a comparison to background concentrations, and action levels, and an evaluation of the frequency of detection. For certain chemicals, no action levels were available, and action levels for related compounds were used. This introduces

some uncertainty into the risk assessment as actual toxicity may be different from the toxicity of the surrogate chemical. Overall, however, the process provided a conservative screen of COCs, and it is unlikely that any chemicals presenting an ecological risk were omitted.

3.5.3 Selection of Representative Species

The selection of representative species in the ERA introduces some uncertainty into the risk estimates. No site-specific biological surveys were conducted at the Oliktok Point installation, with the exception of a survey for spectacled and Steller's eiders (Alaska Biological Research 1994). As a result, it is not known whether or how often the representative species are actually found at the site; however, the uncertainty introduced into the risk estimate by this route is likely to be low. The purpose of ERAs is not to survey the biota at a site, but to estimate the risks to species that may inhabit the area. Surrogate species are commonly used, even if the representative species do not reside specifically at the Oliktok Point installation, the risk estimates in this report provide a sound measure of the potential risks to the species that do inhabit the area.

3.5.4 Exposure Assessment

Exposures were estimated using literature-based life history information for the selected representative species. There is moderate uncertainty associated with the exposure information. Food and water ingestion rates were not available for some animals and had to be estimated from regression equations. Incidental ingestion of soils and sediments may occur while animals are foraging, and it is uncertain how much is actually ingested. In addition, there is uncertainty associated with the habitat associated at the site. Samples were collected around buildings and other structures that are likely to provide habitat of limited quality. As a result, this tends to overestimate exposure. Further, there are significant uncertainties associated with the estimates of how extensively a receptor will use the site, which were based on home range information. As noted in the discussion of estimation of percent ingested onsite (Section 3.2.7.2), the conversion of population density values as substitutes for home ranges adds uncertainty to the risk assessment. The conversion was necessary because home range data are lacking for some of the representative species.

There is some uncertainty associated with the diet compositions estimated from the literature. A good example of this type of uncertainty is the unpredictable fluctuation in the populations of the brown lemmings and their predators (i.e., arctic fox, glaucous gull). As the numbers of prey increase, predator populations may experience numerical and density increases well beyond the values reported in the literature. When prey populations decrease, predation pressure can shift to diet items not considered "normal", that do not represent dietary intakes reported in the literature. Wildlife, and their interactions with the environment around them, are dynamic. Stochastic events, natural or anthropogenic, may cause behavior and/or habits to differ markedly from the "expected or norm". Deviations from typical behavior cause uncertainty when evaluating wildlife and ecosystems.

There is uncertainty associated with exposure estimates for plants. Plant uptake of COCs was derived from a regression equation using the K_{ow} of the COC (Table 3-4). This calculation estimates the concentration of chemicals in the vegetative portion of plants. Actual

concentrations of the COC in plant tissue will vary depending upon actual chemical uptake, species of plant, and other site-specific factors (such as soil organic carbon). It is important to note that screening level tissue concentrations in plants were not available for comparison with these estimated concentrations. The overall effect of this source of uncertainty in the risk assessment is low, as is the ecological risk to plants.

The only component in the diet of representative species evaluated quantitatively was the ingestion of plants. Ingestion of animal prey (e.g., the diet of the arctic fox and the insectivorous portion of some avian diets) was not quantified. This may slightly underestimate risk for species that rely on animal items in their diet.

3.5.5 Toxicological Data

One of the largest sources of uncertainty in risk assessment is from the toxicological data. Often there are not relevant studies for the specific representative species or endpoints. As a result, extrapolations are made, which introduce uncertainty into the risk estimate. These extrapolations incorporate uncertainty factors into the calculation of TRVs. The purpose of the uncertainty factors is to incorporate some margin of error into the risk estimate, in order to arrive at a "safe" level of exposure to which onsite exposure concentrations may be compared. These techniques introduce into the risk assessment a tendency to overestimate rather than underestimate the risk, as conservative estimates were made in estimating toxicity values.

For some chemicals, no toxicity information was available (e.g., avian toxicity values for GRPH, benzene, and tetrachloroethene). As a result, these compounds were not evaluated quantitatively in the risk assessment, and the risk may be somewhat underestimated. Based on the low concentrations and low frequency of detection of these compounds (as discussed in Section 3.1), the uncertainty associated with this factor is low.

Toxicity values for plants, water, soils, and sediments are based on literature values. Toxicity in soils and sediments is affected by the bioavailability of a given chemical. Toxicity of metals in water is based, in part, upon the speciation of the element. As a result, site-specific bioavailability or toxicity may differ from that in the studies used to estimate potential toxic effects. Therefore, actual toxicity of chemicals at the Oliktok Point sites may be different from the values reported in the literature. In addition, the sensitivity of receptors on site may be different from the sensitivity of the species reported in the literature.

There is a great deal of uncertainty in assessing the toxicity of a mixture of chemicals. In this ERA, the effects of exposure from each contaminant have been considered separately. These substances occur together at the site, however, and organisms may be exposed to mixtures of the chemicals. Prediction of how these mixtures of toxicants will interact must be based on an understanding of the mechanisms of such interactions. Interactions of the individual components of chemical mixtures may occur during absorption, distribution, metabolism, excretion, or activity at the receptor site. Individual compounds may interact chemically, yielding a new toxic component or causing a change in the biological availability of an existing component, or may interact by causing different effects at different receptor sites. Suitable data are not currently available to characterize the effects of chemical mixtures rigorously, so chemicals present at the

site were evaluated independently. This approach of assessing risk associated with mixtures of chemicals does not account for any additive, synergistic, or antagonistic interactions among the chemicals considered. However, as discussed in Section 3.6, the risk assessment yielded a low potential for ecological risks, and it is unlikely that additive effects of chemicals are a concern.

3.6 SUMMARY OF ECOLOGICAL RISK

The potential risks to ecological receptors are summarized in this section based on the information presented in Sections 3.1 through 3.5. The reader is referred to these sections for more details on the assessment. Conclusions regarding potential risks must be viewed in the context of the uncertainties associated with the assessment (Section 3.5) and the available risk information. The available risk information includes chemical data, exposure estimates, and literature-based toxicity information. Table 3-23 summarizes the ecological risks at the Oliktok Point installation. The table shows the COCs associated with potential risks (if any) on a site-by-site basis for current and future conditions.

3.6.1 Potential Risks to Representative Plants

A qualitative comparison was conducted of onsite soil and surface water concentrations with plant toxicity information. The risk to plants is characterized by using comparative information from the literature and BCF (B_v). Based on the qualitative comparison, the risks to plants are not significant.

3.6.2 Potential Risks to Representative Aquatic Species

Potential risks to aquatic species were evaluated by comparing toxicity information from the literature with the average exposure concentrations of potential contaminants in surface water. Considering site and COC-specific factors, the overall risk to aquatic organisms at the Oliktok Point installation is not considered significant.

3.6.3 Potential Risks to Representative Species of Birds and Mammals

The risks to representative species of birds and mammals were evaluated using the quotient method. This method compares the estimated exposures with TRVs, resulting in a calculated HQ. In some cases, HQs were not calculated for avian species because of the lack of COC-specific toxicity information; they were evaluated using a qualitative comparison with the mammalian toxicities in Section 3.4.3, Risk Characterization. The resulting risk estimates for all of the avian and mammalian representative species were not significant. In addition, the risks resulting from potential future exposure to COCs (with the exception of PCBs) at the Oliktok Point installation are estimated to be as low as, or lower than the current estimates (i.e., not significant).

The objective of this ERA is to evaluate the potential risk to the representative plant, aquatic, and terrestrial species at the Oliktok Point DEW Line installation. The assessment indicates that, overall, the potential ecological risks currently presented by the COCs at the Oliktok Point sites are not significant. There is potential for ecological risk in the future as a result of PCB

contamination at the Old Landfill (LF01), Garage (SS10), and Old Sewage Area Petroleum Spill (SS11) sites.

3.6.4 Summary of Potential Ecological Risks

The objective of this ERA is to evaluate the potential risk to the representative plant, aquatic, and terrestrial species at the Oliktok Point DEW Line installation. The assessment indicates that the potential ecological risks currently presented by the COCs at the Oliktok Point sites are not significant.

TABLE 3-23. SUMMARY OF ECOLOGICAL RISK ESTIMATES AT THE OLIKTOK POINT SITES

SITE	COC CONTRIBUTING TO RISK	CURRENT RISK POTENTIAL	FUTURE RISK POTENTIAL
Old Landfill (LF01)	None	Not significant	Future risk may increase because of potential bioaccumulation of Aroclor 1254.
Dump Site (LF02)	None	Not significant	Not significant.
Dock Storage Area (S03)	None	Not significant	Not significant.
POL Storage (ST04)	None	Not significant	Not significant.
Diesel Spill (SS05)	None	Not significant	Not significant.
Gasoline Storage Area (ST08)	None	Not significant	Not significant.
Garage (SS10)	None	Not significant	Future risk may increase because of potential bioaccumulation of Aroclor 1254.
Old Storage Area Petroleum Spill (SS11)	None	Not significant	Future risk may increase because of potential bioaccumulation of Aroclor 1254.

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APPENDIX A

RISK CHARACTERIZATION SPREADSHEETS

Old Landfill (LF01) A-1

Dock Storage Area (ST03) A-5

Diesel Spill (SS05) A-9

Gasoline Storage Area (ST08) A-12

Garage (SS10) A-16

Old Sewage Area Petroleum Spill (SS11) A-19

TABLE A-1. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Soil Ingestion
Endpoint: Noncancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Old Landfill (LF01)
File: LF01SONC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion Rate	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	0.000001	0.000001	0.000001
Body Weight	(kg)	70	70	15
Averaging Time	(ED x 365 days/year)	3,650	17,885	2,190

Chemical	Oral RfD	Concentration Soil (mg/kg)	ADD by Receptor Group (mg/kg-day)			Hazard Quotients	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
Aroclor 1254	0.00002	8.1	1.90e-07	3.80e-07	3.55e-06	3.80e-03	7.88e-02
					HAZARD INDEX	0.004	0.079

TABLE A-2. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route:	Soil Ingestion
Endpoint:	Cancer
Assumptions:	Site-specific
Installation:	Oliktok Point
Site:	Old Landfill (LF01)
File:	LF01SOCA.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion Rate	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	0.000001	0.000001	0.000001
Body Weight	(kg)	70	70	15
Averaging Time	(lifetime in days)	25,550	25,550	25,550

Chemical	Carcinogen Oral Slope Factor	Concentration Soil (mg/kg)	LADD by Receptor Group (mg/kg-day)			Cancer Risk	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
PCB (Aroclor 1254)	7.7	8.1	6.79e-08	6.66e-07	7.61e-07	5.23e-07	1.10e-05
					CANCER RISK	5e-07	1e-05

TABLE A-3. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route:	Water Ingestion
Endpoint:	Noncancer
Assumptions:	Site-specific
Installation:	Oliktok Point
Site:	Old Landfill (LF01)
File:	LF01WANC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult
Water Ingestion	(L/day)	2	2
Exposure Frequency	(days/year)	180	180
Exposure Duration	(years)	10	55
Conversion Factor	(kg/mg)	1	1
Body Weight	(kg)	70	70
Averaging Time	(ED x 365 days/year)	3,650	20,075

Chemical	Oral RfD	Concentration Water (mg/L)	ADD by Receptor Group (mg/kg-day)		Hazard Quotient	
			DEW Line Worker	Native Northern Adult	DEW Line Worker	Native Northern Adult
GRPH	0.2	0.07	9.86e-04	9.86e-04	4.93e-03	4.93e-03
				HAZARD INDEX	4.93e-03	4.93e-03

TABLE A-4. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Water Ingestion
Endpoint: Cancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Old Landfill (LF01)
File: LF01WACA.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult
Water Ingestion	(L/day)	2	2
Exposure Frequency	(days/year)	180	180
Exposure Duration	(years)	10	55
Conversion Factor	(kg/mg)	1	1
Body Weight	(kg)	70	70
Averaging Time	(lifetime in days)	25,550	25,550

Chemical	Carcinogen Oral Slope Factor	Concentration Water (mg/L)	LADD by Receptor Group (mg/kg-day)		Cancer Risk	
			DEW Line Worker	Native Northern Adult	DEW Line Worker	Native Northern Adult
GRPH	0.0017	0.07	1.41e-04	7.75e-04	2.40e-07	1.32e-06
				CANCER RISK	2e-07	1e-06

TABLE A-5. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Soil Ingestion
Endpoint: Noncancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Dock Storage Area (ST03)
File: ST03SONC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	1.00E-06	1.00E-06	1.00E-06
Body Weight	(kg)	70	70	15
Averaging Time	(ED x 365 days/year)	3,650	17,885	2,190

Chemical	Oral RfD	Concentration Soil (mg/kg)	ADD by Receptor Group (mg/kg-day)			Hazard Quotient	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
Aroclor 1254	0.00002	0.3	1.76E-08	3.52E-08	3.29E-07	8.81E-04	1.82e-02
					HAZARD INDEX	0.001	0.018

TABLE A-6. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Soil Ingestion
Endpoint: Cancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Dock Storage Area (ST03)
File: ST03SOCA.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	1.00E-06	1.00E-06	1.00E-06
Body Weight	(kg)	70	70	15
Averaging Time	(lifetime in days)	25,550	25,550	25,550

Chemical	Carcinogen Oral Slope Factor	Concentration Soil (mg/kg)	ADD by Receptor Group (mg/kg-day)			Hazard Quotient	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
PCB (Aroclor 1254)	7.7	0.3	2.52E-09	2.47E-08	2.82E-08	1.94E-08	4.07E-07
					CANCER RISK	2E-08	4E-07

TABLE A-7. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route:	Water Ingestion
Endpoint:	Noncancer
Assumptions:	Site-specific
Installation:	Oliktok Point
Site:	Dock Storage Area (ST03)
File:	ST03WANC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult
Water Ingestion	(L/day)	2	2
Exposure Frequency	(days/year)	180	180
Exposure Duration	(years)	10	55
Conversion Factor	(kg/mg)	1	1
Body Weight	(kg)	70	70
Averaging Time	(ED x 365 days/year)	3,650	20,075

Chemical	Oral RfD	Concentration Water (mg/L)	ADD by Receptor Group (mg/kg-day)		Hazard Quotient	
			DEW Line Worker	Native Northern Adult	DEW Line Worker	Native Northern Adult
DRPH	0.08	0.806	1.14e-02	1.14e-02	1.42e-01	1.42e-01
				HAZARD INDEX	1.42e-01	1.42e-01

TABLE A-8. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Water Ingestion
Endpoint: Cancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Dock Storage Area (ST03)
File: ST03WACA.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult
Water Ingestion	(L/day)	2	2
Exposure Frequency	(days/year)	180	180
Exposure Duration	(years)	10	55
Conversion Factor	(kg/mg)	1	1
Body Weight	(kg)	70	70
Averaging Time	(lifetime in days)	25,550	25,550

Chemical	Carcinogen Oral Slope Factor	Concentration Water (mg/L)	LADD by Receptor Group (mg/kg-day)		Cancer Risk	
			DEW Line Worker	Native Northern Adult	DEW Line Worker	Native Northern Adult
1,2-Dichloroethane	0.091	0.0019	3.82e-06	2.10e-05	3.48e-07	1.91e-06
				CANCER RISK	3e-07	2e-06

TABLE A-9. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Soil Ingestion
Endpoint: Noncancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Diesel Spill (SS05)
File: SS05SONC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion Rate	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	0.000001	0.000001	0.000001
Body Weight	(kg)	70	70	15
Averaging Time	(ED x 365 days/year)	3,650	17,885	2,190

Chemical	Oral RfD	Concentration Soil (mg/kg)	ADD by Receptor Group (mg/kg-day)			Hazard Quotients	
			DEW Line Worker	Native Northern Adult	Native Nrthern Child	DEW Line Worker	Native Northern Adult/Child
DRPH	0.08	17,300	1.02e-03	2.03e-03	1.90e-02	1.27e-02	2.62e-01
GRPH	0.2	422	2.48e-05	4.95e-05	4.62e-04	1.24e-04	2.56e-03
					HAZARD INDEX	0.013	0.265

TABLE A-10. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Soil Ingestion
Endpoint: Cancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Diesel Spill (SS05)
File: SS05SOCA.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion Rate	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	0.000001	0.000001	0.000001
Body Weight	(kg)	70	70	15
Averaging Time	(lifetime in days)	25,550	25,550	25,550

Chemical	Carcinogen Oral Slope Factor	Concentration Soil (mg/kg)	LADD by Receptor Group (mg/kg-day)			Cancer Risk	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
GRPH	0.0017	422	3.54e-06	3.47e-05	3.96e-05	6.02e-09	1.26e-07
					CANCER RISK	6e-09	1e-07

TABLE A-11. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Water Ingestion
Endpoint: Noncancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Diesel Spill (SS05)
File:

Exposure Assumptions		DEW Line Worker	Native Northern Adult
Water Ingestion	(L/day)	2	2
Exposure Frequency	(days/year)	180	180
Exposure Duration	(years)	10	55
Conversion Factor	(kg/mg)	1	1
Body Weight	(kg)	70	70
Averaging Time	(ED x 365 days/year)	3,650	20,075

Chemical	Oral RfD	Concentration Water (mg/L)	ADD by Receptor Group (mg/kg-day)		Hazard Quotient	
			DEW Line Worker	Native Northern Adult	DEW Line Worker	Native Northern Adult
DRPH	0.08	0.425	6.00e-03	6e-03	7.50e-02	7.50e-02
				HAZARD INDEX	8e-02	8e-02

TABLE A-12. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route:	Soil Ingestion
Endpoint:	Noncancer
Assumptions:	Site-specific
Installation:	Oliktok Point
Site:	Gasoline Storage Area (ST08)
File:	ST08SONC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion Rate	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	0.000001	0.000001	0.000001
Body Weight	(kg)	70	70	15
Averaging Time	(ED x 365 days/year)	3,650	17,885	2,190

Chemical	Oral RfD	Concentration Soil (mg/kg)	ADD by Receptor Group (mg/kg-day)			Hazard Quotients	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
DRPH	0.08	300,000	1.76e-02	3.52e-02	3.29e-01	2.20e-01	4.55e+00
GRPH	0.2	2,200	1.29e-04	2.58e-04	2.41e-03	6.46e-04	1.33e-02
RRPH	0.08	15,000	8.81e-04	1.76e-03	1.64e-02	1.10e-02	2.27e-01
					HAZARD INDEX	0.232	4.791

TABLE A-13. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Soil Ingestion
Endpoint: Cancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
File: ST08SOCA.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion Rate	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	0.000001	0.000001	0.000001
Body Weight	(kg)	70	70	15
Averaging Time	(lifetime in days)	25,550	25,550	25,550

Chemical	Carcinogen Oral Slope Factor	Concentration Soil (mg/kg)	LADD by Receptor Group (mg/kg-day)			Cancer Risk	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
GRPH	0.0017	2,200	1.85e-05	1.81e-04	2.07e-04	3.14e-08	6.59e-07
Benzene	0.029	12.9	1.08e-07	1.06e-06	1.21e-06	3.14e-09	6.59e-08
					CANCER RISK	3e-08	7e-07

TABLE A-14. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Water Ingestion
Endpoint: Noncancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
File: ST08WANC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult
Water Ingestion	(L/day)	2	2
Exposure Frequency	(days/year)	180	180
Exposure Duration	(years)	10	55
Conversion Factor	(kg/mg)	1	1
Body Weight	(kg)	70	70
Averaging Time	(ED x 365 days/year)	3,650	20,075

Chemical	Oral RfD	Concentration Water (mg/L)	ADD by Receptor Group (mg/kg-day)		Hazard Quotient	
			DEW Line Worker	Native Northern Adult	DEW Line Worker	Native Northern Adult
bis (2-Ethylhexyl)Phthalate	0.02	0.048	6.76e-04	6.76e-04	3.38e-02	3.38e-02
				HAZARD INDEX	3.38e-02	3.38e-02

TABLE A-15. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Water Ingestion
Endpoint: Cancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
File: ST08WACA.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult
Water Ingestion	(L/day)	2	2
Exposure Frequency	(days/year)	180	180
Exposure Duration	(years)	10	55
Conversion Factor	(kg/mg)	1	1
Body Weight	(kg)	70	70
Averaging Time	(lifetime in days)	25,550	25,550

Chemical	Carcinogen Oral Slope Factor	Concentration Water (mg/L)	LADD by Receptor Group (mg/kg-day)		Cancer Risk	
			DEW Line Worker	Native Northern Adult	DEW Line Worker	Native Northern Adult
1,2-Dichloroethane	0.091	0.001	2.01e-06	1.11e-05	1.83e-07	1.01e-06
bis (2-Ethylhexyl)Phthalate	0.014	0.048	9.66e-05	5.31e-04	1.35e-06	7.44e-06
				CANCER RISK	2e-06	8e-06

TABLE A-16. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Soil Ingestion
Endpoint: Noncancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Garage (SS10)
File: SS10SONC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion Rate	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	0.000001	0.000001	0.000001
Body Weight	(kg)	70	70	15
Averaging Time	(ED x 365 days/year)	3,650	17,885	2,190

Chemical	Oral RfD	Concentration Soil (mg/kg)	ADD by Receptor Group (mg/kg-day)			Hazard Quotients	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
DRPH	0.08	75,000	4.40e-03	8.81e-03	8.22e-02	5.50e-02	1.14e+00
GRPH	0.2	1,500	8.81e-05	1.76e-04	1.64e-03	4.40e-04	9.10e-03
Tetrachloroethene	0.01	7.6	4.46e-07	8.92e-07	8.33e-06	4.46e-05	9.22e-04
RRPH	0.08	52,000	3.05e-03	6.11e-03	5.70e-02	3.82e-02	7.89e-01
bis(2-Ethylhexyl)phthalate	0.02	5.53	3.25e-07	6.49e-07	6.06e-06	1.62e-05	3.35e-04
Aroclor 1254	0.00002	3	1.76e-07	3.52e-07	3.29e-06	8.81e-03	1.82e-01
					HAZARD INDEX	0.103	2.118

TABLE A-17. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Soil Ingestion
Endpoint: Cancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Garage (SS10)
File: SS10SOCA.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion Rate	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	0.000001	0.000001	0.000001
Body Weight	(kg)	70	70	15
Averaging Time	(lifetime in days)	25,550	25,550	25,550

Chemical	Carcinogen Oral Slope Factor	Concentration Soil (mg/kg)	LADD by Receptor Group (mg/kg-day)			Cancer Risk	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
GRPH	0.0017	1,500	1.26e-05	1.23e-04	1.41e-04	2.14e-08	4.49e-07
Benzene	0.029	3.5	2.94e-08	2.88e-07	3.29e-07	8.51e-10	1.79e-08
Tetrachloroethene	0.052	7.6	6.37e-08	6.25e-07	7.14e-07	3.31e-09	6.96e-08
bis(2-Ethylhexyl)phthalate	0.014	5.53	4.64e-08	4.55e-07	5.19e-07	6.59e-10	1.38e-08
Aroclor 1254	7.7	3	2.52e-08	2.47e-07	2.82e-07	1.94e-07	4.08e-06
					CANCER RISK	2e-07	5e-06

TABLE A-18. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route:	Water Ingestion
Endpoint:	Noncancer
Assumptions:	Site-specific
Installation:	Oliktok Point
Site:	Garage (SS10)
File:	SS10WANC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult
Water Ingestion	(L/day)	2	2
Exposure Frequency	(days/year)	180	180
Exposure Duration	(years)	10	55
Conversion Factor	(kg/mg)	1	1
Body Weight	(kg)	70	70
Averaging Time	(ED x 365 days/year)	3,650	20,075

Chemical	Oral RfD	Concentration Water (mg/L)	ADD by Receptor Group (mg/kg-day)		Hazard Quotient	
			DEW Line Worker	Native Northern Adult	DEW Line Worker	Native Northern Adult
Barium	0.07	0.29	4.09e-03	4.09e-03	5.84e-02	5.84e-02
				HAZARD INDEX	5.84e-02	5.84e-02

TABLE A-19. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Soil Ingestion
Endpoint: Noncancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
File: SS01SONC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion Rate	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	0.000001	0.000001	0.000001
Body Weight	(kg)	70	70	15
Averaging Time	(ED x 365 days/year)	3,650	17,885	2,190

Chemical	Oral RfD	Concentration Soil (mg/kg)	ADD by Receptor Group (mg/kg-day)			Hazard Quotients	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
DRPH	0.08	4,700	2.76e-04	5.52e-04	5.15e-03	3.45e-03	7.13e-02
GRPH	0.2	389	2.28e-05	4.57e-05	4.26e-04	1.14e-04	2.36e-03
Aroclor 1254	0.00002	0.045	2.64e-09	5.28e-09	4.93e-08	1.32e-04	2.73e-03
					HAZARD INDEX	0.004	0.076

TABLE A-20. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Soil Ingestion
Endpoint: Cancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
File: SS01SOCA.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult	Native Northern Child
Soil Ingestion Rate	(mg/day)	50	100	200
Exposure Frequency	(days/year)	30	30	30
Exposure Duration	(years)	10	49	6
Conversion Factor	(kg/mg)	0.000001	0.000001	0.000001
Body Weight	(kg)	70	70	15
Averaging Time	(lifetime in days)	25,550	25,550	25,550

Chemical	Carcinogen Oral Slope Factor	Concentration Soil (mg/kg)	LADD by Receptor Group (mg/kg-day)			Cancer Risk	
			DEW Line Worker	Native Northern Adult	Native Northern Child	DEW Line Worker	Native Northern Adult/Child
GRPH	0.0017	389	3.26e-06	3.20e-05	3.65e-05	5.55e-09	1.16e-07
Aroclor 1254	7.7	0.045	3.77e-10	3.70e-09	4.23e-09	2.91e-09	6.10e-08
					CANCER RISK	8e-09	2e-07

TABLE A-21. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Water Ingestion
Endpoint: Noncancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
File: SS01WANC.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult
Water Ingestion	(L/day)	2	2
Exposure Frequency	(days/year)	180	180
Exposure Duration	(years)	10	55
Conversion Factor	(kg/mg)	1	1
Body Weight	(kg)	70	70
Averaging Time	(ED x 365 days/year)	3,650	2,0075

Chemical	Oral RfD	Concentration Water (mg/L)	ADD by Receptor Group (mg/kg-day)		Hazard Quotient	
			DEW Line Worker	Native Northern Adult	DEW Line Worker	Native Northern Adult
DRPH	0.08	1.11	1.56e-02	1.56e-02	1.95e-01	1.95e-01
GRPH	0.2	0.142	2.00e-03	2.00e-03	1.00e-02	1.00e-02
Barium	0.07	0.75	1.06e-02	1.06e-02	1.51e-01	1.51e-01
Copper	0.037	0.57	8.03e-03	8.03e-03	2.17e-01	2.17e-01
Manganese	0.005	2.5	3.52e-02	3.52e-02	7.05e+00	7.05e+00
Vanadium	0.007	0.066	9.30e-04	9.30e-04	1.33e-01	1.33e-01
				HAZARD INDEX	7.75e+00	7.75e+00

TABLE A-22. DEW LINE INSTALLATION RISK ASSESSMENT SPREADSHEET

Route: Water Ingestion
Endpoint: Cancer
Assumptions: Site-specific
Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
File: SS01WACA.WK1

Exposure Assumptions		DEW Line Worker	Native Northern Adult
Water Ingestion	(L/day)	2	2
Exposure Frequency	(days/year)	180	180
Exposure Duration	(years)	10	55
Conversion Factor	(kg/mg)	1	1
Body Weight	(kg)	70	70
Averaging Time	(lifetime in days)	25,550	25,550

Chemical	Carcinogen Oral Slope Factor	Concentration Water (mg/L)	LADD by Receptor Group (mg/kg-day)		Cancer Risk	
			DEW Line Worker	Native Northern Adult	DEW Line Worker	Native Northern Adult
GRPH	0.0017	0.142	2.86e-04	1.57e-03	4.86e-07	2.67e-06
1,2-Dichloroethane	0.091	0.0033	6.64e-06	3.65e-05	6.04e-07	3.32e-06
				CANCER RISK	1e-06	6e-06

APPENDIX G

RI ANALYTICAL DATA

G-1. SUMMARY OF SAMPLING AND ANALYSIS CONDUCTED FOR OLIKTOK POINT REMEDIAL INVESTIGATIONS G-1

G-2. BACKGROUND ANALYTICAL DATA SUMMARY G-3

G-3. OLD LANDFILL ANALYTICAL DATA SUMMARY G-9

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TABLE G-1. SUMMARY OF SAMPLING AND ANALYSES CON

ANALYSES	HVOC*	VOC 8010	BTEX*	VOC 8260	SVOC	Metals[b]	TPH-Diesel[b] Range 3510/3550	T
ANALYTICAL METHOD	SW8010M	SW8010M	SW8020	SW8260	SW8270	SW3050 (Soil) 3005 (Water)/6010	Diesel 8100M	G
OLIKTOK POINT								
Background	NA	5 Soil 1 Water	5 Soil 2 Water	5 Soil 2 Water	5 Soil 2 Water	5 Soil 2 Water (Total) 2 Water (Dissolved)	5 Soil 2 Water	
Old Landfill (LF01)	6 Soil 3 Water	NA	6 Soil 3 Water	2 Soil 1 Water	2 Soil 1 Water	2 Soil 1 Water (Total) 1 Water (Dissolved)	6 Soil 3 Water	
Dump Site (LF02)	5 Soil 1 Water	NA	5 Soil 1 Water	2 Soil 1 Water	2 Soil 1 Water	2 Soil 1 Water (Total) 1 Water (Dissolved)	5 Soil 1 Water	
Dock Storage Area (ST03)	4 Soil	1 Water	4 Soil 1 Water	2 Soil 1 Water	2 Soil 1 Water	1 Water (Total) 1 Water (Dissolved)	4 Soil 1 Water	
POL Storage (ST04)	NA	NA	3 Soil	1 Soil	NA	NA	3 Soil	
Diesel Spill (SS05)	NA	NA	14 Soil 2 Water	1 Soil 1 Water	1 Soil 1 Water	NA	16 Soil 2 Water	
Gasoline Storage Area (ST08)	13 Soil 3 Water	NA	16 Soil 3 Water	3 Soil 1 Water	2 Soil 1 Water	2 Soil 1 Water (Total) 1 Water (Dissolved)	26 Soil 3 Water	
Garage (SS10)	11 Soil	NA	11 Soil 1 Water	4 Soil 1 Water	1 Soil 1 Water	1 Soil 1 Water (Total) 1 Water (Dissolved)	14 Soil 1 Water	
Old Sewage Outfall Petroleum Spill (SS11)	NA	8 Soil 3 Water	10 Soil 3 Water	2 Soil 1 Water	2 Soil 1 Water	2 Soil 1 Water (Total) 1 Water (Dissolved)	14 Soil 3 Water	
Total Field Analyses	39 Soil 7 Water	13 Soil 5 Water	74 Soil 16 Water	22 Soil 9 Water	17 Soil 9 Water	14 Soil 8 Water (Total) 8 Water (Dissolved)	93 Soil 16 Water	
QA/QC SAMPLES								
Trip Blanks	3 Water	2 Water	5 Water	6 Water	NA	NA	NA	
Equipment Blanks	2 Water	2 Water	5 Water	5 Water	4 Water	4 Water (Total) 1 Water (Dissolved)	3 Water	
Ambient Condition Blanks	NA	1 Water	1 Water	2 Water	NA	NA	NA	
Field Replicates	5 Soil	1 Soil	8 Soil	3 Soil	2 Soil	2 Soil	11 Soil	
Field Duplicates	NA	1 Water	1 Water	1 Water	1 Water	1 Water (Total) 1 Water (Dissolved)	1 Water	
Investigation Derived Wastes (IDW)	NA	NA	NA	2 Water	NA	1 Water (Total)	2 Water	

NA Not analyzed.
* These analyses were completed on a quick turnaround basis.
a The number of soil sample includes sediment samples collected from surface water features.
b Some of these analysis were completed on a 24-hour turnaround at a temporary fixed laboratory at Barrow, Alaska.
d Investigation derived wastes from Oliktok Point were combined with the investigation derived wastes from Bullen Point. The

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YSES CONDUCTED FOR OLIKTOK POINT REMEDIAL INVESTIGATIONS[a]

-Diesel[b] Range 10/3550	TPH - Gasoline[b] Range	TPH Residual Range*	PCB*	Pesticides*	TDS	TSS	TOC	TCLP[d]	TOTAL SAMPLES
el 8100M	Gas 5030/8015M	Diesel 8100M	SW8080/8080M	SW8080/8080M	E160.1	E160.2	SW9060	SW1311	
5 Soil Water	5 Soil 2 Water	NA	5 Soil 2 Water	5 Soil 2 Water	2 Water	2 Water	2 Water	NA	5 Soil 2 Water
3 Soil Water	6 Soil 3 Water	6 Soil 3 Water	6 Soil 3 Water	NA	1 Water	1 Water	1 Water	NA	6 Soil 3 Water
5 Soil Water	5 Soil 1 Water	5 Soil 1 Water	5 Soil 1 Water	NA	1 Water	1 Water	1 Water	NA	5 Soil 1 Water
4 Soil Water	4 Soil 1 Water	4 Soil	4 Soil 1 Water	1 Water	1 Water	1 Water	1 Water	NA	4 Soil 1 Water
3 Soil	3 Soil	NA	NA	NA	NA	NA	NA	NA	3 Soil
6 Soil Water	14 Soil 2 Water	3 Soil	NA	NA	1 Water	1 Water	1 Water	NA	16 Soil 2 Water
26 Soil Water	16 Soil 3 Water	26 Soil 3 Water	13 Soil 3 Water	2 Soil	1 Water	1 Water	1 Water	NA	26 Soil 3 Water
4 Soil Water	11 Soil 1 Water	14 Soil 1 Water	11 Soil	NA	NA	NA	NA	NA	14 Soil 1 Water
4 Soil Water	10 Soil 3 Water	6 Soil	8 Soil 3 Water	2 Soil 1 Water	1 Water	1 Water	1 Water	NA	14 Soil 3 Water
3 Soil Water	74 Soil 16 Water	64 Soil 8 Water	52 Soil 13 Water	9 Soil 4 Water	8 Water	8 Water	8 Water	NA	93 Soil 16 Water
NA	3 Water	NA	NA	NA	NA	NA	NA	NA	6 Water
Water	5 Water	2 Water	3 Water	2 Water	NA	NA	NA	NA	5 Water
NA	NA	NA	NA	NA	NA	NA	NA	NA	2 Water
1 Soil	8 Soil	8 Soil	6 Soil	1 Soil	NA	NA	NA	NA	11 Soil
Water	1 Water	NA	1 Water	NA	1 Water	1 Water	1 Water	NA	1 Water
Water	NA	2 Water	2 Water	1 Water	NA	NA	NA	2 Water	2 Water

aska.
en Point. These were collectively sampled during the Oliktok Point investigation.

(1)

TABLE G-1. SUMMARY OF SAMPLING AND ANALYSES CONDUCTE

ANALYSES	HVOC*	VOC 8010	BTEX*	VOC 8260	SVOC	Metals[b]	TPH-Diesel[b] Range 3510/3550	T
ANALYTICAL METHOD	SW8010M	SW8010M	SW8020	SW8260	SW8270	SW3050 (Soil) 3005 (Water)/6010	Diesel 8100M	G
Total Site Analyses	44 Soil 12 Water	14 Soil 11 Water	82 Soil 28 Water	25 Soil 25 Water	19 Soil 14 Water	16 Soil 14 Water (Total) 10 Water (Dissolved)	104 Soil 22 Water	

NA Not analyzed.
* These analyses were completed on a quick turnaround basis.
a The number of soil sample includes sediment samples collected from surface water features.
b Some of these analysis were completed on a 24-hour turnaround at a temporary fixed laboratory at Barrow, Alaska.
d Investigation derived wastes from Oliktok Point were combined with the investigation derived wastes from Bullen Point. The

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NDUCTED FOR OLIKTOK POINT REMEDIAL INVESTIGATIONS[a] (CONTINUED)

iesel[b] ge 3550	TPH - Gasoline[b] Range	TPH Residual Range*	PCB*	Pesticides*	TDS	TSS	TOC	TCLP[d]	TOTAL SAMPLES
3100M	Gas 5030/8015M	Diesel 8100M	SW8080/8080M	SW8080/8080M	E160.1	E160.2	SW9060	SW1311	
Soil 'ater	82 Soil 25 Water	72 Soil 12 Water	58 Soil 19 Water	10 Soil 7 Water	9 Water	9 Water	9 Water	2 Water	104 Soil 32 Water

(a.
Point. These were collectively sampled during the Oliktok Point investigation.

TABLE G-2 BACKGROUND ANALYTICAL DATA SUMMARY

Installation: Oliktok Point   Matrix: Soil/Sediment
Site: Background (BKGD)   Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks	
					S01	S02	S03	S04	SD01	AB01	EB01	TB01		
Laboratory Sample ID Numbers					4176-1 4280-1	4176-2 4280-4	4176-3 4280-7	4176-4 4280-8	4176-5 4280-9	4209-7 4214-6	4172-1 4174-2 4279-2	4174-1 4279-1	4174 4279 4209 4214	4176 4280
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	13.8J-167J	113[d]	121[d]	88.8[d]	167J[d]	13.8J[d]	NA	<200	NA	<200	<4.0
GRPH	0.400	0.600-1.00	100	<0.600-<1.00	<0.800	<0.600	<0.600	<0.800	<1.00	NA	<20	NA	<20	<0.400
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<0.250	<0.150	<0.150	<0.200	<0.300					
Benzene	0.020	0.030-0.060	0.5	<0.030-<0.060	<0.050	<0.030	<0.030	<0.040	<0.060	<1	<1	<1	<1	<0.020
Toluene	0.020	0.030-0.060		<0.030-<0.060	<0.050	<0.030	<0.030	<0.040	<0.060	<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.030-0.060		<0.030-<0.060	<0.050	<0.030	<0.030	<0.040	<0.060	<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.060-0.120		<0.060-<0.120	<0.100	<0.060	<0.060	<0.080	<0.120	<2	<2	<2	<2	<0.040
VOC 8010	0.020	0.030-0.060		<0.030-<0.060	<0.050	<0.030	<0.030	<0.040	<0.060	<1	<1	<1	<1	<0.020
VOC 8260	0.020	0.030-0.045		<0.030-<0.045	<0.040	<0.035	<0.040	<0.030	<0.045	<1	<1-1	<1	<1	<0.020
SVOC 8270	0.200	0.330-3.30		<0.330-<3.30	<3.30	<2.80	<2.80	<2.70	<0.330	NA	<10.1	NA	<10	<0.200
Pesticides	0.001	0.005-0.100		<0.005-<0.100	<0.008-<0.080	<0.005-<0.090	<0.005-<0.030	<0.005J-<0.030J	<0.010-<0.100	NA	<0.1-<2	NA	<0.1-<2	<0.005
PCBs	0.020	0.030-0.100	10	<0.030-<0.100	<0.080	<0.030	<0.030	<0.030J	<0.100	NA	<2	NA	<2	<0.020

☐ CT&E Data.
NA Not analyzed.
J Result is an estimate.
a The action level for DRPH is based on conversations with ADEC; a final action level has not yet been determined.
d The laboratory reported the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-2. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Background (BKGD)

Matrix: Soil/Sediment
Units: mg/kg

METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Bkgd. Levels	Environmental Samples						Field Blank			Lab Blanks
						S01	S02	S03	S04	SD01			EB01		
Laboratory Sample ID Numbers						4176-1	4176-2	4176-3	4176-4	4176-5			4172-2		4176 4172
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			µg/L		µg/L
Aluminum	0.35	2		1,500-25,000	1,800-15,000	11,000	15,000	12,000	8,400	1,800			<100		<100
Antimony	N/A	66-85		<7.8-<230	<66-<85	<81	<71	<71	<66R	<85R			<100		<100
Arsenic	0.11	2-8.1		<4.9-8.5	<6.6-8.5	<8.1	<7.1	<7.1	<6.6	8.5			<100		<100
Barium	0.024	1		27-390	66-280	280	200	240	190	66			<50		<50
Beryllium	N/A	1-4.3		<2.6-6.4	<4.3-6.4	5.7	6.4	4.4	4.0	<4.3			<50		<50
Cadmium	0.33	1		<3.0-<36	<3.3-4.4	4.4	<36	<3.6	<3.3	<4.3			<50		<50
Calcium	0.69	4		360-59,000	1,500-5,600	5,600	2,500	5,200	4,000	1,500			250		<200
Chromium	0.066	1-4.3		<4.3-47	<4.3-21	16	21	18	14J	<4.3J			<50		<50
Cobalt	N/A	1-8.5		<5.1-12	<6.5-11	11	7.1	<6.5	<6.6	<8.5			<100		<100
Copper	0.045	1-41		<2.7-45	<4.3-7.4	<41	7.4	<9.8	<8.1	<4.3			<50		<50
Iron	0.50	2		5,400-35,000	7,600-27,000	23,000	27,000	18,000	16,000	7,600			380		<100
Lead	0.13	66-71		<5.1-22	<6.6-<71	<8.1	<71	<7.1	<6.6	<8.5			<100		<100
Magnesium	0.96	4		360-7,400	610-2,900	2,200	2,900	2,400	2,100	610			<200		<200
Manganese	0.025	1		25-290	51-280	280	180	210	51	110			<50		<50
Molybdenum	N/A	3.3-4.3		<2.5-<11	<3.3-<4.3	<4.1	<3.6	<3.6	<3.3	<4.3			<50		<50
Nickel	0.11	1		4.2-46	5.8-16	16	15	16	13	5.8			<50		<50
Potassium	23	100-420		<300-2,200	<420-1,300	1,000	1,300	1,100	750	<420			<5,000		<5,000

☐ CT&E Data.
N/A Not available.
J Result is an estimate.
R Result has been rejected.

TABLE G-2. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Background (BKGD)

Matrix: Soil/Sediment
Units: mg/kg

METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Bkgd. Levels	Environmental Samples						Field Blank			Lab Blanks
						S01	S02	S03	S04	SD01			EB01		
Laboratory Sample ID Numbers						4176-1	4176-2	4176-3	4176-4	4176-5			4172-2		4176 4172
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			µg/L		µg/L
Selenium	1.2	66-85		<7.8-170	<66-<85	<81	<71	<71	<66	<85			<100		<100
Silver	0.53	3.3-4.3		<3-<110	<3.3-<4.3	<4.1	<3.6	<3.6	<3.3	<4.3			<50		<50
Sodium	0.55	5		<160-680	55-220	220	200	190	150	55			480		NA
Thallium	0.011	0.33-0.41		<0.2-<1.2	<0.33-0.41	<0.41	<0.35	<0.35	<0.33	<0.41			<5		<5
Vanadium	0.036	1		6.3-59	6.3-37	30	37	30	25	6.3			<50		<50
Zinc	0.16	1		9.2-95	17-50	36	50	33	30	17			<50		<50

☐ CT&E Data.
NA Not analyzed

TABLE G-2. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point — Matrix: Surface Water
Site: Background (BKGD) — Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks
					SW01	SW02				AB01	EB01	TB01	
Laboratory Sample ID Numbers					4174-3 4279-3	4174-4 4279-6				4209-7 4214-6	4172-1 4174-2 4279-2	4174-1 4279-1	4279 4174 4214
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L				µg/L	µg/L	µg/L	µg/L
DRPH	100	100		392[ad]-457J[ad]	392[ad]	457J[ad]				NA	<200	NA	<200
GRPH	20	20		<20	<20	<20				NA	<20	NA	<20
BTEX (8020/8020 Mod.)													
Benzene	1	1	5	<1	<1	<1				<1	<1	<1	<1
Toluene	1	1	1,000	<1	<1	<1				<1	<1	<1	<1
Ethylbenzene	1	1	700	<1	<1	<1				<1	<1	<1	<1
Xylenes (Total)	2	2	10,000	<2	<2	<2				<2	<2	<2	<2
VOC 8010	1	1		<1	<1	NA				<1	<1	<1	<1
VOC 8260	1	1		<1	<1	<1				<1	<1-1	<1	<1
SVOC 8270	10	10		<10	<10	<10J				NA	<10.1	NA	<10
Pesticides	0.005	0.1-2		<0.1-<2	<0.1-<2	<0.1-<2				NA	<0.1-<2	NA	<0.1-<2
PCBs	1	1-2	0.5	<1-<2	<2	<1-<2				NA	<2	NA	<1-<2
TOC	5,000	5,000		6,700-14,400	6,700	14,400				NA	NA	NA	<5,000
TSS	100	200		6,000-9,000	6,000	9,000				NA	NA	NA	<200
TDS	10,000	10,000		212,000-352,000	212,000	352,000				NA	NA	NA	12,000

□ CT&E Data.
NA Not analyzed.
J Result is an estimate.
a Total petroleum hydrocarbons in these water samples exceed the 15 µg/L stated for fresh water in ADEC's Water Quality Criteria 18AAC70 (ADEC 1989).
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-2. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point | Matrix: Surface Water | METALS ANALYSES: TOTAL (DISSOLVED)
Site: Background (BKGD) | Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Bkgd. Levels	Environmental Samples					Field Blank			Lab Blanks
						SW01	SW02					EB01		
Laboratory Sample ID Numbers						4174-3	4174-4					4172-2		4174 4172
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L					µg/L		µg/L
Aluminum	17.4	100		<100-350 (<100-340)	<100 (<100)	<100 (<100)	<100 (<100)					<100		<100 (<100)
Antimony	N/A	100	6	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)					<100		<100 (<100)
Arsenic	5.3	100	50	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)					<100		<100 (<100)
Barium	1.2	50	2,000	<50-93 (<50-91)	58-93 (57-91)	58 (57)	93 (91)					<50		<50 (<50)
Beryllium	N/A	50	4	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)					<50		<50 (<50)
Cadmium	1.7	50	5	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)					<50		<50 (<50)
Calcium	34.5	200		4,500-88,000 (4,100-86,000)	34,000-38,000 (34,000-38,000)	34,000 (34,000)	38,000 (38,000)					250		<200 (<200)
Chromium	3.29	50	100	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)					<50		<50 (<50)
Cobalt	N/A	100		<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)					<100		<100 (<100)
Copper	2.3	50	1,300	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)					<50		<50 (<50)
Iron	25	100		180-2,800 (<100- 1,600)	210-440 (120-150)	210 (120)	440 (150)					380		<100 (<100)
Lead	6.6	100	15	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)					<100		<100 (<100)

☐ CT&E Data.
N/A Not available.

TABLE G-2. BACKGROUND ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Background (BKGD)

Matrix: Surface Water
Units: µg/L

METALS ANALYSES: TOTAL
(DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Bkgd. Levels	Environmental Samples					Field Blank			Lab Blanks
						SW01	SW02					EB01		
Laboratory Sample ID Numbers						4174-3	4174-4					4172-2		4174 4172
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L					µg/L		µg/L
Magnesium	47.8	200		<5,000-53,000 (2,600-54,000)	4,100-10,000 (4,000-11,000)	4,100 (4,000)	10,000 (11,000)					<200		<200 (<200)
Manganese	1.24	50		<50-510 (<50-120)	<50 (<50)	<50 (<50)	<50 (<50)					<50		<50 (<50)
Molybdenum	N/A	50		<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)					<50		<50 (<50)
Nickel	5.5	50	100	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)					<50		<50 (<50)
Potassium	1,154	5,000		<5,000 (5,000)	<5,000 (<5,000)	<5,000 (<5,000)	<5,000 (<5,000)					<5,000		<5,000 (<5,000)
Selenium	62.4	100	50	<100 (<100)	<100 (<100)	<100 (<100)	<100 (<100)					<100		<100 (<100)
Silver	2.6	50	50	<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)					<50		<50 (<50)
Sodium	27.7	250		8,400-410,000 (8,200-450,000)	15,000-43,000 (15,000-49,000)	15,000 (15,000)	43,000 (44,000)					480		<250 (<250)
Thallium	0.57	5	2	<5 (<5)	<5 (<5)	<5 (<5)	<5 (<5)					<5		<5 (<5)
Vanadium	1.8	50		<50 (<50)	<50 (<50)	<50 (<50)	<50 (<50)					<50		<50 (<50)
Zinc	8.2	50		<50-160 (<50)	<50 (<50)	<50 (<50)	<50 (<50)					<50		<50 (<50)

☐ CT&E Data.
N/A Not available.

TABLE G-3. OLD LANDFILL ANALYTICAL DATA SUMMARY

Installation: Oliktok Point
Site: Old Landfill (LF01)

Matrix: Soil/Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					S01	S02	S03-1.5	S04	SD01	SD02	AB01	EB03	TB03		
Laboratory Sample ID Numbers					164/165 4267-4	166/167	168/169	170/171	160/161 4267-1	162/163	4209-7 4214-6	192/195 4268-2	190 4268-1	#1&2-82093 #5-82093 4209/4214 4268	#5-81993 #5-82093 #1&2-82093 4267
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5	50	500[a]	13.8J[d]-167J[d]	<50[b]	<50[b]	<50[b]	<50[b]	<50[b]	<50[b]	NA	<1,000[b]	NA	NA	<50
GRPH	0.1	1	100	<0.600-<1.00	<1J[b]	<1J[b]	5J[b]	<1J[b]	<1J[b]	<1J[b]	NA	<50J[b]	<50J[b]	<50	<1
RRPH (Approx.)	10	100	2000[a]	NA	<100	<100	<100	<100	<100	<100	NA	<1000	NA	NA	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<0.10J	<0.10	0.26J	<0.10	<0.10	<0.10					
Benzene	0.002	0.02	0.5	<0.030-<0.060	<0.02J	<0.02	<0.02	<0.02	<0.02	<0.02	<1	<1	<1	<1	<0.02
Toluene	0.002	0.02		<0.030-<0.060	<0.02J	<0.02	0.1	<0.02	<0.02	<0.02	<1	<1	<1	<1	<0.02
Ethylbenzene	0.002	0.02		<0.030-<0.060	<0.02J	<0.02	0.1	<0.02	<0.02	<0.02	<1	<1	<1	<1	<0.02
Xylenes (Total)	0.004	0.04		<0.060-<0.120	<0.04J	<0.04	0.06J	<0.04	<0.04	<0.04	<2	<2	<2	<2	<0.04
HVOC 8010															
Tetrachloroethene	0.002	0.02		NA	<0.02J	<0.02	0.04	<0.02	<0.02	<0.02	NA	<1	<1	<1	<0.02
Trichloroethane	0.002	0.02		NA	<0.02J	<0.02	0.4J	<0.02	<0.02	<0.02	NA	<1	<1	<1	<0.02
VOC 8260	0.020	0.025		<0.030-<0.045	<0.025	NA	NA	NA	<0.025	NA	<1	<1-3.3	<1	<1	<0.020
SVOC 8270	0.20	0.230-0.949		<0.330-<3.30	<0.230-0.949U	NA	NA	NA	<0.230-<1.00	NA	NA	<22	NA	<10	<0.010
PCBs															
Aroclor 1254	0.01	0.1	10	<0.030-<0.100	0.8J	<0.1	8.1J	<0.1	<0.1	<0.1	NA	<2	NA	NA	<0.01

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
U Compound is not present above the concentration listed.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-3. OLD LANDFILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point | Matrix: Soil/Sediment | METALS ANALYSES
Site: Old Landfill (LF01) | Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples					Field Blank	Lab Blanks
					S01	SD01				EB03	
Laboratory Sample ID Numbers					4267-4	4267-1				4268-2	4267 4268
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg				µg/L	µg/L
Aluminum	0.35	2		1,500-25,000	1,600J	2,100				<100	<100
Antimony	N/A	53-57		<7.8-<230	<53J	<57				<100	<100
Arsenic	0.11	5.3-5.7		<4.9-8.5	<5.3	<5.7				<100	<100
Barium	0.024	1		27-390	100	130				<50	<50
Beryllium	N/A	2.7-2.9		<2.6-6.4	<2.7	<2.9				<50	<50
Cadmium	0.33	2.7-2.9		<3.0-<3.6	<2.7	<2.9				<50	<50
Calcium	0.69	4		360-59,000	4,800J	4,200				<200	<200-378
Chromium	0.066	1		<4.3-47	4.1J	16				<50	<50
Cobalt	N/A	5.3-5.7		<5.1-12	<5.3	<5.7				<100	<100
Copper	0.045	1-19		<2.7-45	<19	8.6				<50	<50
Iron	0.50	2		5,400-35,000	5,800	7,600				<100	<100
Lead	0.13	2-5.7		<5.1-22	69	<5.7				<100	<100
Magnesium	0.96	4		360-7,400	1,100	1,100				<200	<200
Manganese	0.25	1		25-290	73	160				<50	<50
Molybdenum	N/A	2.7-2.9		<2.5-<11	<2.7	<2.9				<50	<50
Nickel	0.11	1		4.2-46	6.5	14				<50	<50

☐ CT&E Data.
N/A Not available.
J Result is an estimate.

TABLE G-3. OLD LANDFILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Landfill (LF01)

Matrix: Soil/Sediment
Units: mg/kg

METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples					Field Blank	Lab Blanks
					S01	SD01				EB03	
Laboratory Sample ID Numbers					4267-4	4267-1				4268-2	4267 4268
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg				µg/L	µg/L
Potassium	23	100		<300-2,200	340	320				<5,000	<5,000
Selenium	1.2	5.3-5.7		<7.8-<170	<5.3	<5.7				<100	<100
Silver	0.53	2.7-2.9		<3-<110	<2.7	<2.9				<50	<50
Sodium	0.55	5		<160-680	1,000	370				290	<250
Thallium	0.011	0.28-0.29		<0.2-<1.2	<0.29	<0.28				<5	<5
Vanadium	0.036	1		6.3-59	6.9	7.5				<50	<50
Zinc	0.16	1		9.2-95	30	27				<50	<50

☐ CT&E Data.

TABLE G-3. OLD LANDFILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Landfill (LF01)

Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples			Field Blanks			Lab Blanks
					SW01	SW02	SW03	AB01	EB03	TB03	
Laboratory Sample ID Numbers					196/199 4268-3	200/203	204/207	4209-7 4214-6	192/195 4268-2	190 4268-1	#1&2-82093 4209 4214 4268
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
DRPH	10	1,000		392[ad]-457J[ad]	<1,000[b]	<1,000J[b]	<1,000[b]	NA	<1,000[b]	NA	NA
GRPH	5	50		<20	<50J[b]	<50J[b]	70J[ab]	NA	<50J[b]	<50J[b]	<50
RRPH (Approx.)	100	1,000		NA	<1,000	<1,000	<1,000	NA	<1,000	NA	NA
BTEX (8020/8020 Mod.)											
Benzene	0.1	1	5	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	0.1	1	1,000	<1	<1	<1	24	<1	<1	<1	<1
Ethylbenzene	0.1	1	700	<1	<1	<1	3	<1	<1	<1	<1
Xylenes (Total)	0.2	2	10,000	<2	<2	<2	31J	<2	<2	<2	<2
HVOC 8010	0.1	1		NA	<1	<1	<1	NA	<1	<1	<1
VOC 8260	1	1-2.7		<1	<1-2.7U	NA	NA	<1	<1-3.3	<1	<1
SVOC 8270	10	22		<10	<22	NA	NA	NA	<22	NA	<10
PCBs	0.2	2	0.5	<1-<2	<2	<2J	<2	NA	<2	NA	NA
TOC	5,000	5,000		6,700-14,400	18,100J	NA	NA	NA	NA	NA	<5,000

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
U Compound is not present above the concentration listed.
a Total petroleum hydrocarbons in these water samples exceed the 15 µg/L stated for fresh water in ADEC's Water Quality Criteria 18AAC70 (ADEC 1989).
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
d The laboratory reported that the EPH in this sample was pattern not consistent with a middle distillate fuel.

TABLE G-3. OLD LANDFILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Landfill (LF01)

Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples			Field Blanks			Lab Blanks
					SW01	SW02	SW03	AB01	EB03	TB03	
Laboratory Sample ID Numbers					196/199 4268-3	200/203	204/207	4209-7 4214-6	192/195 4268-2	190 4268-1	#1&2-82093 4209 4214 4268
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
TSS	100	100		6,000-9,000	35,000	NA	NA	NA	NA	NA	<100
TDS	10,000	10,000		212,000-352,000	3,912,000	NA	NA	NA	NA	NA	<10,000

☐ CT&E Data.

TABLE G-3. OLD LANDFILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Landfill (LF01)

Matrix: Surface Water
Units: µg/L

METALS ANALYSES: TOTAL
(DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blank
					SW01						EB03	
Laboratory Sample ID Numbers					4268-3						4268-2	4268
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Aluminum	17.4	100		<100-350 (<100-340)	300 (<100)						<100	<100 (<100)
Antimony	N/A	100	6	<100 (<100)	<100 (<100)						<100	<100 (<100)
Arsenic	5.3	100	50	<100 (<100)	<100 (<100)						<100	<100 (<100)
Barium	1.2	50	2,000	<50-93 (<50-91)	170 (150)						<50	<50 (<50)
Beryllium	N/A	50	4	<50 (<50)	<50 (<50)						<50	<50 (<50)
Cadmium	1.7	50	5	<50 (<50)	<50 (<50)						<50	<50 (<50)
Calcium	34.5	200		4,500-88,000 (4,100-86,000)	85,000J (80,000)						<200	378 (378)
Chromium	32.9	50	100	<50 (<50)	<50 (<50)						<50	<50 (<50)
Cobalt	N/A	100		<100 (<100)	<100 (<100)						<100	<100 (<100)
Copper	2.3	50	1,300	<50 (<50)	<50 (<50)						<50	<50 (<50)

☐ CT&E Data.
N/A Not available.
J Result is an estimate.

TABLE G-3. OLD LANDFILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point | Matrix: Surface Water | METALS ANALYSES: TOTAL
Site: Old Landfill (LF01) | Units: μg/L | (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blank
					SW01						EB03	
Laboratory Sample ID Numbers					4268-3						4268-2	4268
ANALYSES	μg/L	μg/L	μg/L	μg/L	μg/L						μg/L	μg/L
Iron	25	100		180-2,800 (<100-1,600)	2,300 (200)						<100	<100 (<100)
Lead	6.6	100	15	<100 (<100)	<100 (<100)						<100	<100 (<100)
Magnesium	47.8	200		<5,000-53,000 (2,600-54,000)	59,000 (59,000)						<200	<200 (<200)
Manganese	1.24	50		<50-510 (<50-120)	360 (290)						<50	<50 (<50)
Molybdenum	N/A	50		<50 (<50)	<50 (<50)						<50	<50 (<50)
Nickel	5.5	50	100	<50 (<50)	<50 (<50)						<50	<50 (<50)
Potassium	1,154	5,000		<5,000 (5,000)	13,000 (14,000)						<5,000	<5,000 (<5,000)
Selenium	62.4	100	50	<100 (<100)	<100 (<100)						<100	<100 (<100)
Silver	2.6	50	50	<50 (<50)	<50 (<50)						<50	<50 (<50)
Sodium	27.7	250		8,400-410,000 (8,200-450,000)	490,000 (460,000)						290	<250 (<250)

☐ CT&E Data.
N/A Not available.

TABLE G-3. OLD LANDFILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Landfill (LF01)

Matrix: Surface Water
Units: µg/L

METALS ANALYSES: TOTAL
(DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blank
					SW01						EB03	
Laboratory Sample ID Numbers					4268-3						4268-2	4268
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Thallium	0.57	5	2	<5 (<5)	<5 (<5)						<5	<5 (<5)
Vanadium	1.8	50		<50 (<50)	<50 (<50)						<50	<50 (<50)
Zinc	8.2	50		<50-160 (<50)	<50 (<50)						<50	<50 (<50)

☐ CT&E Data.

TABLE G-4. DUMP SITE ANALYTICAL DATA SUMMARY

Installation: Oliktok Point Matrix: Soil
Site: Dump Site (LF02) Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks	
					S01-3	S02-1.5	S03-1.5	S04-1.5 & S05-1.5 (Replicates)		AB01	EB03	TB03		
Laboratory Sample ID Numbers					176/177	178/179	180/181 4267-7	186/187	188/189	4209-7 4214-6	192/195 4268-2	190 4268-1	#1&2-82093 4209/4214 4268	#5-81993 #1&2-82093 4267
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5-10	50-100	500[a]	13.8J[d]-167J[d]	<50[b]	<50[b]	<70[b]	<50[b]	<100[b]	NA	<1,000[b]	NA	NA	<50
GRPH	0.1-0.2	1-2	100	<0.600-<1.00	<1J[b]	<1J[b]	<1J[b]	<1[b]	<2J[b]	NA	<50J[b]	<50J[b]	<50	<1
RRPH (Approx.)	10	100	2,000[a]	NA	<100	<100	<100	<100	<100	NA	<1,000	NA	NA	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<0.10	<0.10	<0.15	<0.10	<0.20J					
Benzene	0.002-0.004	0.02-0.04	0.5	<0.030-<0.060	<0.02	<0.02	<0.03	<0.02	<0.04J	<1	<1	<1	<1	<0.02
Toluene	0.002-0.004	0.02-0.04		<0.030-<0.060	<0.02	<0.02	<0.03	<0.02	<0.04J	<1	<1	<1	<1	<0.02
Ethylbenzene	0.002-0.004	0.02-0.04		<0.030-<0.060	<0.02	<0.02	<0.03	<0.02	<0.04J	<1	<1	<1	<1	<0.02
Xylenes (Total)	0.004-0.008	0.04-0.08		<0.060-<0.120	<0.04	<0.04	<0.06	<0.04	<0.08J	<2	<2	<2	<2	<0.04
HVOC 8010	0.002-0.004	0.02-0.04		NA	<0.02	<0.02	<0.03	<0.02	<0.04J	NA	<1	<1	<1	<0.02
VOC 8260														
Toluene	0.020	0.070		<0.030-<0.045	NA	NA	0.096	NA	NA	<1	<1	<1	<1	<0.020
SVOC 8270	0.200	6.00		<0.330-<3.30	NA	NA	<6.00	NA	NA	NA	<22	NA	<10	<0.200
PCBs	0.01-0.02	0.1-0.2	10	<0.030-<0.100	<0.1	<0.1	<0.1	<0.1	<0.2	NA	<2	NA	NA	<0.01-<0.1

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-4. DUMP SITE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Dump Site (LF02)

Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples: SD01 & SD02 (Replicates)			Field Blanks: AB01	EB03	TB03	Lab Blanks	
Laboratory Sample ID Numbers					182/183 4267-8	184/185 4267-9		4209-7 4214-6	192/195 4268-2	190 4268-1	#1&2-82093 4209/4214 4268	#5-81993 #1&2-82093 4267
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	9-16	90-160	500[a]	13.8J[d]-167J[d]	<160[b]	<90[b]		NA	<1,000[b]	NA	NA	<50
GRPH	0.2-0.3	2-3	100	<0.600-<1.00	<3J[b]	<2J[b]		NA	<50J[b]	<50J[b]	<50	<1
RRPH (Approx.)	10	100	2,000[a]	NA	<100	<100		NA	<1,000	NA	NA	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<0.31	<0.20						
Benzene	0.004-0.006	0.04-0.06	0.5	<0.030-<0.060	<0.06	<0.04		<1	<1	<1	<1	<0.02
Toluene	0.004-0.006	0.04-0.06		<0.030-<0.060	<0.06	<0.04		<1	<1	<1	<1	<0.02
Ethylbenzene	0.004-0.006	0.04-0.06		<0.030-<0.060	<0.06	<0.04		<1	<1	<1	<1	<0.02
Xylenes (Total)	0.008-0.013	0.08-0.13		<0.060-<0.120	<0.13	<0.08		<2	<2	<2	<2	<0.04
HVOC 8010	0.004-0.006	0.04-0.06		NA	<0.06	<0.04		NA	<1	<1	<1	<0.02
VOC 8260	0.020	0.040-0.065		<0.030-<0.045	<0.040	<0.065		<1	<1-3.3	<1	<1	<0.020
SVOC 8270	0.200	4.00-5.90		<0.330-<3.30	<4.00	<5.90		NA	<22	NA	<22	<0.200
PCBs	0.02-0.03	0.2-0.3	10	<0.030-<0.100	<0.3	<0.2		NA	<2	NA	NA	<0.01-<0.1

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-4. DUMP SITE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Dump Site (LF02)

Matrix: Soil/Sediment
Units: mg/kg

METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples					Field Blank	Lab Blanks
					S03-1.5	SD01 & SD02 (Replicates)				EB03	
Laboratory Sample ID Numbers					4267-7	4267-8	4267-9			4268-2	4267 4268
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			µg/L	µg/L
Aluminum	0.35	2		1,500-25,000	7,300J	4,400	6,900			<100	<100
Antimony	N/A	81-120		<7.8-<230	<120J	<81	<111			<100	<100
Arsenic	0.11	8.1-12		<4.9-8.5	<12	<8.1	<11			<100	<100
Barium	0.024	1		27-390	260	130	200			<50	<50
Beryllium	N/A	4.1-6.1		<2.6-6.4	<6.1	<4.1	<5.6			<50	<50
Cadmium	0.33	4.1-6.1		<3.0-<36	<6.1	<4.1	<5.6			<50	<50
Calcium	0.69	4		360-59,000	9,200J	7,100	11,000			<200	<200-378
Chromium	0.066	1		<4.3-47	12J	8.4J	12J			<50	<50
Cobalt	N/A	8.1-12		<5.1-12	<12	<8.1	<11			<100	<100
Copper	0.045	1		<2.7-45	9.1	7.7	16			<50	<50
Iron	0.50	2		5,400-35,000	13,000	9,800	17,000			<100	<100
Lead	0.13	2-12		<5.1-22	<12	<8.1	20			<100	<100
Magnesium	0.96	4		360-7,400	1,700	3,300	2,700			<200	<200
Manganese	0.025	1		25-290	100	120	410			<50	<50
Molybdenum	N/A	4.1-6.1		<2.5-<11	<6.1	<4.1	<5.6			<50	<50

☐ CT&E Data.
N/A Not available.
J Result is an estimate.

TABLE G-4. DUMP SITE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point Matrix: Soil/Sediment METALS ANALYSES
Site: Dump Site (LF02) Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples					Field Blank	Lab Blanks
					S03-1.5	SD01 & SD02 (Replicates)				EB03	
Laboratory Sample ID Numbers					4267-7	4267-8	4267-9			4268-2	4267 4268
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			µg/L	µg/L
Nickel	0.11	1		4.2-46	11	11	16			<50	<50
Potassium	23	100-610		<300-2,200	<610	580	980			<5,000	<5,000
Selenium	1.2	2-111		<7.8-<170	<12	<8.1	<111			<100	<100
Silver	0.53	4.1-6.1		<3-<110	<6.1	<4.1	<5.6			<50	<50
Sodium	0.55	5		<160-680	980	350	660			290	<250
Thallium	0.011	0.26-0.61		<0.2-<1.2	<0.61	<0.26	<0.55			<5	<5
Vanadium	0.036	1		6.3-59	17	15	20			<50	<50
Zinc	0.16	1		9.2-95	20	33	84			<50	<50

☐ CT&E Data.

TABLE G-4. DUMP SITE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Dump Site (LF02)

Matrix: Surface Water
Units: μg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Sample					Field Blanks			Lab Blanks
					SW01					AB01	EB03	TB03	
Laboratory Sample ID Numbers					212/215 4268-4					4209-7 4214-6	192/195 4268-2	190 4268-1	#1&2-82093 4209/4214 4268
ANALYSES	μg/L	μg/L	μg/L	μg/L	μg/L					μg/L	μg/L	μg/L	μg/L
DRPH	50	500		392[ad]-457J[ad]	<1,000[b]					NA	<1,000[b]	NA	NA
GRPH	5	50		<20	<50J[b]					NA	<50J[b]	<50J[b]	<50
RRPH (Approx.)	100	1,000		NA	<1,000					NA	<1,000	NA	NA
BTEX (8020/8020 Mod.)													
Benzene	0.1	1	5	<1	<1					<1	<1	<1	<1
Toluene	0.1	1	1,000	<1	<1					<1	<1	<1	<1
Ethylbenzene	0.1	1	700	<1	<1					<1	<1	<1	<1
Xylenes (Total)	0.2	2	10,000	<2	<2					<2	<2	<2	<2
HVOC 8010	0.1	1		NA	<1					NA	<1	<1	<1
VOC 8260	1	1.6		<1	<1-1.6U					<1	<1-3.3	<1	<1
SVOC 8270	10	22		<10	<22					NA	<22	NA	<10

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
U Compound is not present above the concentration listed.
a Total petroleum hydrocarbons in these water samples exceed the 15 μ/gL stated for fresh water in ADEC's water Quality Criteria 18AAC70 (ADEC 1989).
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-4. DUMP SITE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Dump Site (LF02)

Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Sample					Field Blanks			Lab Blanks
					SW01					AB01	EB03	TB03	
Laboratory Sample ID Numbers					212/215 4268-4					4209-7 4214-6	192/195 4268-2	190 4268-1	4268
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L					µg/L	µg/L	µg/L	µg/L
PCBs	0.2	2	0.5	<1-<2	<2					NA	<2	NA	NA
TOC	5,000	5,000		6,700-14,400	15,500J					NA	NA	NA	<5,000
TSS	100	100		6,000-9,000	12,000					NA	NA	NA	<100
TDS	10,000	10,000		212,000-352,000	726,000					NA	NA	NA	<10,000

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.

TABLE G-4. DUMP SITE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Dump Site (LF02)

Matrix: Surface Water
Units: µg/L

METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blank
					SW01						EB03	
Laboratory Sample ID Numbers					4268-4						4268-2	4268
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Aluminum	17.4	100		<100-350 (<100-340)	180 (<100)						<100	<100 (<100)
Antimony	N/A	100	6	<100 (<100)	<100 (<100)						<100	<100 (<100)
Arsenic	5.3	100	50	<100 (<100)	<100 (<100)						<100	<100 (<100)
Barium	1.2	50	2,000	<50-93 (<50-91)	200 (190)						<50	<50 (<50)
Beryllium	N/A	50	4	<50 (<50)	<50 (<50)						<50	<50 (<50)
Cadmium	1.7	50	5	<50 (<50)	<50 (<50)						<50	<50 (<50)
Calcium	34.5	200		4,500-88,000 (4,100-86,000)	67,000J (64,000)						<200	378 (378)
Chromium	3.29	50	100	<50 (<50)	<50 (<50)						<50	<50 (<50)
Cobalt	N/A	100		<100 (<100)	<100 (<100)						<100	<100 (<100)
Copper	2.3	50	1,300	<50 (<50)	<50 (<50)						<50	<50 (<50)

☐ CT&E Data.
N/A Not available.
J Result is an estimate.

TABLE G-4. DUMP SITE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Dump Site (LF02)

Matrix: Surface Water
Units: µg/L

METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blank
					SW01						EB03	
Laboratory Sample ID Numbers					4268-4						4268-2	4268
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Iron	25	100		180-2,800 (<100-1,600)	920 (200)						<100	<100 (<100)
Lead	6.6	100	15	<100 (<100)	<100 (<100)						<100	<100 (<100)
Magnesium	47.8	200		<5,000-53,000 (2,600-54,000)	26,000 (26,000)						<200	<200 (<200)
Manganese	1.24	50		<50-510 (<50-120)	62 (<50)						<50	<50 (<50)
Molybdenum	N/A	50		<50 (<50)	<50 (<50)						<50	<50 (<50)
Nickel	5.5	50	100	<50 (<50)	<50 (<50)						<50	<50 (<50)
Potassium	1,154	5,000		<5,000 (<5,000)	<5,000 (5,100)						<5,000	<5,000 (<5,000)
Selenium	62.4	100	50	<100 (<100)	<100 (<100)						<100	<100 (<100)
Silver	2.6	50	50	<50 (<50)	<50 (<50)						<50	<50 (<50)
Sodium	27.7	250		8,400-410,000 (8,200-450,000)	95,000 (100,000)						290	<250 (<250)
Thallium	0.57	5	2	<5 (<5)	<5 (<5)						<5	<5 (<5)

☐ CT&E Data.
N/A Not available.

TABLE G-4. DUMP SITE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point Matrix: Surface Water METALS ANALYSES: TOTAL
Site: Dump Site (LF02) Units: µg/L (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blank
					SW01						EB03	
Laboratory Sample ID Numbers					4268-4						4268-2	4268
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Vanadium	1.8	50		<50 (<50)	<50 (<50)						<50	<50 (<50)
Zinc	8.2	50		<50-160 (<50)	<50 (<50)						<50	<50 (<50)

☐ CT&E Data.

TABLE G-5. DOCK STORAGE AREA ANALYTICAL DATA SUMMARY

Installation: Oliktok Point
Site: Dock Storage Area (ST03)

Matrix: Soil/Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples: S01-0.8 & S05-0.8 (Replicates)		Environmental Samples: S02	Environmental Samples: S03-3	Environmental Samples: SD01	Field Blanks: AB01	Field Blanks: EB03	Field Blanks: TB03	Lab Blanks	
Laboratory Sample ID Numbers					174/175	210/211	172/173	208/209 4267-6	216/217 4267-8	4209-7 4214-8	192/195 4268-2	190 4268-1	#1&2-82093 4209 4214 4268	#5-82093 #5-81993 #1&2-82093 4267
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5-6	50-60	500[a]	13.8J[d]-167J[d]	300[b]	80[b]	<50[b]	<60[b]	<50[b]	NA	<1,000[b]	NA	NA	<50
GRPH	0.1-0.2	1-2	100	<0.600-<1.00	<1J[b]	<1J[b]	<1J[b]	<1J[b]	<2J[b]	NA	<50J[b]	<50J[b]	<50	<1
RRPH (Approx.)	10	100	2,000[a]	NA	<100	<100	<100	<100	<100	NA	<1,000	NA	NA	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	0.06J	0.08J	<0.10	<0.10	<0.20					
Benzene	0.002-0.004	0.02-0.04	0.5	<0.030-<0.060	<0.02	<0.02	<0.02	<0.02	<0.04	<1	<1	<1	<1	<0.02
Toluene	0.002-0.004	0.02-0.04		<0.030-<0.060	<0.02	<0.02	<0.02	<0.02	<0.04	<1	<1	<1	<1	<0.02
Ethylbenzene	0.002-0.004	0.02-0.04		<0.030-<0.060	0.02	<0.02	<0.02	<0.02	<0.04	<1	<1	<1	<1	<0.02
Xylenes (Total)	0.004-0.008	0.04-0.08		<0.060-<0.120	0.04J	0.08J	<0.04	<0.04	<0.08	<2	<2	<2	<2	<0.04
HVOC 8010	0.002-0.004	0.02-0.04		<0.030-<0.060	<0.02	<0.02	<0.02	<0.02	<0.04	NA	<1	<1	<1	<0.02
VOC 8260	0.020	0.030-0.045		<0.030-<0.045	NA	NA	NA	<0.030	<0.045	<1	<1-3.3	<1	<1	<0.020
SVOC 8270	0.200	0.270-3.50		<0.330-<3.30	NA	NA	NA	<0.270-<1.50	<3.50	NA	<22	NA	<10	<0.900
PCBs														
Aroclor 1254	0.01-0.02	0.1-0.2	10	<0.030-<0.100	<0.1	<0.1J	0.3J	<0.1	<0.2	NA	<2	NA	NA	<0.01

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-5. DOCK STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point Matrix: Surface Water
Site: Dock Storage Area (ST03) Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples				Field Blanks			Lab Blanks
					SW01				AB01	EB02	TB02	
Laboratory Sample ID Numbers					4209-12 4210-9 4217-16	4214-8			4209-7 4214-6	4209-6 4214-5	4209-11 4214-7	4209, 4217 4214, 4209 4210
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L			µg/L	µg/L	µg/L	µg/L
DRPH	100	100		392[ad]-457J[ad]	806[ad]	282[ad]			NA	NA	NA	<100
GRPH	20	20		<20	<20	<20			NA	<20	NA	<20
BTEX (8020/8020 Mod.)												
Benzene	1	1	5	<1	<1	<1			<1	<1	<1	<1
Toluene	1	1	1,000	<1	<1	<1			<1	<1	<1	<1
Ethylbenzene	1	1	700	<1	<1	<1			<1	<1	<1	<1
Xylenes (Total)	2	2	10,000	<2	<2	<2			<2	<2	<2	<2
VOC 8010	1	1		<1	<1	<1			<1	<1	<1	<1
VOC 8260												
1,2-Dichloroethane	1	1	5	<1	1.9	NA			<1	<1	<1	<1
SVOC 8270	10	10-14		<10	<14	<10-<10.5			NA	<10J	NA	<10
Pesticides	0.05	0.1-3		<0.1-<2	<0.3-<3	<0.1-<1			NA	NA	NA	<0.1-<1
PCBs	1	1-3	0.5	<1-<2	<3	<1			NA	NA	NA	<1
TOC	5,000	5,000		6,700-14,400	20,400	NA			NA	NA	NA	<5,000
TSS	100	100		6,000-9,000	29,000	NA			NA	NA	NA	<100
TDS	10,000	10,000		212,000-352,000	2,484,000	NA			NA	NA	NA	<10,000

☐ CT&E Data.
NA Not analyzed.
J Result is an estimate.
a Total petroleum hydrocarbons in these water samples exceed the 15 µg/L stated for fresh water in ADEC's Water Quality Criteria 18AAC70 (ADEC 1989).
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-5. DOCK STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point   Matrix: Surface Water   METALS ANALYSES: TOTAL
Site: Dock Storage Area (ST03)   Units: µg/L   (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blanks
					SW01						EB02	
Laboratory Sample ID Numbers					4209-12 4210-9						4210-3	4210 4209
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Aluminum	17.4	100		<100-350 (<100-340)	270 (150)						<100 (<100)	<100 (<100)
Antimony	N/A	100	6	<100 (<100)	<100 (<100)						<100 (<100)	<100 (<100)
Arsenic	5.3	100	50	<100 (<100)	<100 (<100)						<100 (<100)	<100 (<100)
Barium	1.2	50	2,000	<50-93 (<50-91)	250 (240)						<50 (<50)	<50 (<50)
Beryllium	N/A	50	4	<50 (<50)	<50 (<50)						<50 (<50)	<50 (<50)
Cadmium	1.7	50	5	<50 (<50)	<50 (<50)						<50 (<50)	<50 (<50)
Calcium	34.5	200		4,500-88,000 (4,100-86,000)	100,000 (100,000)						230 (<200)	<200 (<200)
Chromium	3.29	50	100	<50 (<50)	<50 (<50)						<50 (<50)	<50 (<50)
Cobalt	N/A	100		<100 (<100)	<100 (<100)						<100 (<100)	<100 (<100)
Copper	2.3	50	1,300	<50 (<50)	<50 (<50)						<50 (<50)	<50 (<50)

☐ CT&E Data.
N/A Not available.

TABLE G-5. DOCK STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point   Matrix: Surface Water   METALS ANALYSES: TOTAL
Site: Dock Storage Area (ST03)   Units: µg/L   (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blanks
					SW01						EB02	
Laboratory Sample ID Numbers					4209-12 4210-9						4210-3	4210 4209
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Iron	25	100		180-2,800 (<100-1,600)	1,000 (210)						<100 (<100)	792 (792)
Lead	6.6	100	15	<100 (<100)	<100 (<100)						<100 (<100)	<100 (<100)
Magnesium	47.8	200		<5,000-53,000 (2,600-54,000)	85,000 (85,000)						<200 (<200)	<200 (<200)
Manganese	1.24	50		<50-510 (<50-120)	130 (100)						<50 (<50)	<50 (<50)
Molybdenum	N/A	50		<50 (<50)	<50 (<50)						<50 (<50)	<50 (<50)
Nickel	5.5	50	100	<50 (<50)	<50 (<50)						<50 (<50)	82 (82)
Potassium	1,154	5,000		<5,000 (<5,000)	20,000 (21,000)						<5,000 (<5,000)	<5,000 (<5,000)
Selenium	62.4	100	50	<100 (<100)	<100 (<100)						<100 (<100)	<100 (<100)
Silver	2.6	50	50	<50 (<50)	<50 (<50)						<50 (<50)	<50 (<50)
Sodium	27.7	250		8,400-410,000 (8,200-450,000)	590,000 (530,000)						570 (500)	<250 (<250)

☐ CT&E Data.
N/A Not available.

TABLE G-5. DOCK STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Dock Storage Area (ST03)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blanks
					SW01						EB02	
Laboratory Sample ID Numbers					4209-12 4210-9						4210-3	4210 4209
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Thallium	0.57	5	2	<5 (<5)	<5 (<5)						<5 (<5)	<5 (<5)
Vanadium	1.8	50		<50 (<50)	<50 (<50)						<50 (<50)	<50 (<50)
Zinc	8.2	50		<50-160 (<50)	<50 (<50)						<50 (<50)	<50 (<50)

☐ CT&E Data.

TABLE G-6. POL STORAGE ANALYTICAL DATA SUMMARY

Installation: Oliktok Point
Site: POL Storage (ST04)

Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples			Field Blanks			Lab Blanks	
					S01-1.5	S02-1	S03-1.5	AB01	EB02	TB02		
Laboratory Sample ID Numbers					4209-1 4217-1	4217-2	4217-5	4209-7 4214-6	4209-6 4214-5	4209-11 4214-7	4209 4214	4217 4209
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	13.8J[d]-167J[d]	<4.00	<4.00	<4.00	NA	NA	NA	NA	<4.00
GRPH	0.400	0.400-0.500	100	<0.600-<1.00	<0.400	<0.500	1.03	NA	<20	NA	<20	<0.400
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<0.100	<0.125	0.151					
Benzene	0.020	0.020-0.025	0.5	<0.030-<0.060	<0.020	<0.025	<0.025	<1	<1	<1	<1	<0.020
Toluene	0.020	0.020-0.025		<0.030-<0.060	<0.020	<0.025	0.054	<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.020-0.025		<0.030-<0.060	<0.020	<0.025	<0.025	<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.040-0.050		<0.060-<0.120	<0.040	<0.050	0.097	<2	<2	<2	<2	<0.040
VOC 8260	0.020	0.020		<0.030-<0.045	<0.020	NA	NA	<1	<1	<1	<1	<0.020

☐ CT&E Data.
NA Not analyzed.
J Result is an estimate.
a The action level for DRPH is based on conversations with ADEC; a final action level has not yet been determined.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-7. DIESEL SPILL ANALYTICAL DATA SUMMARY

Installation: Oliktok Point
Site: Diesel Spill (SS05)

Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					S01-1	S02-1 & S04-1 (Replicates)		S03-0.7	S05-4	S06-3	AB01	EB01	TB01		
Laboratory Sample ID Numbers					4176-6 4280-12	4280-13	4280-15	4280-14	4218-4	4218-5	4209-7 4214-6	4172-1 4279-2 4174-2	4174-1 4279-1	4209 4214 4172 4174 4279	4280 4218 4176
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	13.8J[d]-167J[d]	401J[c]	1,610	1,260	5.65[d]	3,210	7.07[d]	NA	<200	NA	<200	<4.0
GRPH	0.400	0.400	100	<0.600-<1.00	3.60	213	175	<0.500	422	<0.400	NA	<20	NA	<20	<0.400
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	0.231	3.534	1.572	<0.125	11.57	<0.100					
Benzene	0.020	0.020-1.50	0.5	<0.030-<0.060	<0.020	<0.020	<0.020	<0.025	<1.50	<0.020	<1	<1	<1	<1	<0.020
Toluene	0.020	0.020-1.50		<0.030-<0.060	<0.020	<0.020	<0.020	<0.025	<1.50	<0.020	<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.020-1.50		<0.030-<0.060	0.042	0.748	0.651	<0.025	2.35	<0.020	<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.040-3.0		<0.060-<0.120	0.189	2.786	0.921	<0.050	9.22	<0.040	<2	<2	<2	<2	<0.040
VOC 8260															
n-Butylbenzene	0.020	0.025		<0.030-<0.045	0.079	NA	NA	NA	NA	NA	<1	<1	<1	<1	<0.020
p-Isopropyltoluene	0.020	0.025		<0.030-<0.045	0.057	NA	NA	NA	NA	NA	<1	<1	<1	<1	<0.020
Naphthalene	0.020	0.025		<0.030-<0.045	0.501	NA	NA	NA	NA	NA	<1	<1	<1	<1	<0.020
Toluene	0.020	0.025		<0.030-<0.045	0.051	NA	NA	NA	NA	NA	<1	<1	<1	<1	<0.020
1,2,4-Trimethylbenzene	0.020	0.025		<0.030-<0.045	0.486	NA	NA	NA	NA	NA	<1	<1	<1	<1	<0.020
1,3,5-Trimethylbenzene	0.020	0.025		<0.030-<0.045	0.232	NA	NA	NA	NA	NA	<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.050		<0.060-<0.090	0.482	NA	NA	NA	NA	NA	<2	<2	<2	<2	<0.040
SVOC 8270	0.020	0.230		<0.330-<3.30	<0.230	NA	NA	NA	NA	NA	NA	<10.1	NA	<10	<0.200

☐ CT&E Data.
NA Not analyzed.
J Result is an estimate.
a The action level for DRPH is based on conversations with ADEC; a final action level has not yet been determined.
c The laboratory reported that 34 mg/kg of the EPH pattern in this sample was not consistent with a middle distillate fuel.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-7. DIESEL SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Diesel Spill (SS05)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks	
					S07-3.5	S08	S09	S10	S11	AB01	EB02	TB02		
Laboratory Sample ID Numbers					4218-6	4218-7	4218-8	4218-9	4218-10	4214-6	4214-5 4209-6	4214-7	4214 4209	4218
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	13.8J[c]-167J[c]	13.0[c]	130[d]	17,300	5,210	<4.00	NA	NA	NA	NA	<4.00
GRPH	0.400	0.400	100	<0.600-<1.00	<0.400	0.888	134	19.3	<0.400	NA	<20	NA	<20	<0.400
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<0.100	<0.200	9.90	0.652	<0.100					
Benzene	0.020	0.020-3.00	0.5	<0.030-<0.060	<0.020	<0.040	<3.00	<0.030	<0.020	<1	<1	<1	<1	<0.020
Toluene	0.020	0.020-3.00		<0.030-<0.060	<0.020	<0.040	<3.00	<0.030	<0.020	<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.020-3.00		<0.030-<0.060	<0.020	<0.040	<3.00	0.120	<0.020	<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.040-6.00		<0.060-<0.120	<0.040	<0.080	9.90	0.532	<0.040	<2	<2	<2	<2	<0.040

☐ CT&E Data.
NA Not analyzed.
J Result is an estimate.
a The action level for DRPH is based on conversations with ADEC; a final action level has not yet been determined.
c The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.
d The laboratory reported that 54 mg/kg of the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-7. DIESEL SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point   Matrix: Soil/Sediment
Site: Diesel Spill (SS05)   Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples: S12-3.5 & S13-3.5 (Replicates)		Environmental Samples: SD01	Environmental Samples: SD02	Field Blanks: AB01	Field Blanks: EB01	Field Blanks: EB02	Field Blanks: TB02	Lab Blanks	
Laboratory Sample ID Numbers					4218-11	4218-12	4280-10	4280-11	4214-6	4174-2	4209-6 4214-5	4214-7	4214 4174 4209	4280 4218
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	13.8J[f]-167J[f]	5.75[d]	6.23[e]	821	943	NA	<200	NA	NA	<100	<4.00
GRPH	0.400	0.400	100	<0.600-<1.00	<0.400	<0.400	43.3	3.90	NA	<20	<20	NA	<20	<0.400
BTEX (8020/8020 Mod.)			15 Total BTEX	<0.150-<0.300	0.149	0.29	0.768	0.950						
Benzene	0.020	0.020-0.035	0.5	<0.030-<0.060	<0.020	<0.020	<0.035	<0.025	<1	<1	<1	<1	<1	<0.020
Toluene	0.020	0.020-0.035		<0.030-<0.060	0.113	0.29	<0.035	<0.025	<1	<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.020-0.035		<0.030-<0.060	<0.020	<0.020	0.256	0.10	<1	<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.040-0.070		<0.060-<0.120	0.036[c]	<0.040	0.512	0.850	<2	<2	<2	<2	<2	<0.040

☐ CT&E Data.
NA Not analyzed.
J Result is an estimate.
a The action level for DRPH is based on conversations with ADEC; a final action level has not yet been determined.
c Result is indicative of p & m xylenes only.
d The laboratory reported that 2.52 mg/kg of the EPH pattern in this sample was not consistent a with middle distillate fuel.
e The laboratory reported that 2.45 mg/kg of the EPH pattern in this sample was not consistent a with middle distillate fuel.\
f The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-7. DIESEL SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point — Matrix: Soil
Site: Diesel Spill (SS05) — Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples			Field Blanks			Lab Blanks	
					2S14-1.5	2S15-0.66	2S16-0.75	AB02	2EB05	2TB05		
Laboratory Sample ID Numbers					1830	1832	1833	4263-4	1844	1848	#1&2-9793 4263	#5-9693 #1&2-9793
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	7-12	70-120	<500[a]	13.8J[d]-167J[d]	<80[b]	<120[b]	<60[b]	NA	NA	NA	NA	<50
GRPH	0.2	2	100	<0.600-<1.00	<2J[b]	NA	NA	NA	<50J[b]	<50J[b]	<50	<1
RRPH (Approx.)	14-24	140-240	2,000[a]	NA	<140	<240	<140	NA	NA	NA	NA	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<0.20	NA	NA					
Benzene	0.003	0.03	0.5	<0.030-<0.060	<0.03	NA	NA	<1[c]	<1	<1	<1	<0.02
Toluene	0.002	0.02		<0.030-<0.060	<0.02	NA	NA	<1[c]	<1	<1	<1	<0.02
Ethylbenzene	0.005	0.05		<0.030-<0.060	<0.05	NA	NA	<1[c]	<2	<1	<1	<0.02
Xylenes (Total)	0.01	0.1		<0.060-<0.120	<0.1	NA	NA	<2[c]	<5	<2	<2	<0.04

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-7. DIESEL SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point Matrix: Surface Water
Site: Diesel Spill (SS05) Units: μg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blanks			Lab Blanks
					SW01	SW02				AB01	EB01	TB01	
Laboratory Sample ID Numbers					4172-5 4174-5 4279-7	4279-8				4209-7 4214-6	4172-1 4174-2 4279-2	4174-1 4279-1	4172/4174 4209/4214 4279
ANALYSES	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L				μg/L	μg/L	μg/L	μg/L
DRPH	100	100		392^{ad}-$457J^{ad}$	425^{ad}	403^{ad}				NA	<200	NA	<200
GRPH	20	20		<20	<20	<20				NA	<20	NA	<20
BTEX (8020/8020 Mod.)													
Benzene	1	1	5	<1	<1	<1				<1	<1	<1	<1
Toluene	1	1	1,000	<1	<1	<1				<1	<1	<1	<1
Ethylbenzene	1	1	700	<1	<1	<1				<1	<1	<1	<1
Xylenes (Total)	2	2	10,000	<2	<2	<2				<2	<2	<2	<2
VOC 8260													
1,2-Dichloroethane	1	1	5	<1	2.2B	NA				<1	1	<1	<1
SVOC 8270	10	10.8		<10	<10.8	NA				NA	<10.1	NA	<10
TOC	5,000	5,000		6,700-14,400	17,300	NA				NA	NA	NA	<5,000
TSS	100	200		6,000-9,000	9,000	NA				NA	NA	NA	<200
TDS	10,000	10,000		212,000-352,000	484,000	NA				NA	NA	NA	12,000

☐ CT&E Data.
NA Not analyzed.
B The analyte was detected in the associated blank.
J Result is an estimate.
a Total petroleum hydrocarbons in these water samples exceed the 15 μg/L stated for fresh water in ADEC's Water Quality Criteria 18AAC70 (ADEC 1989).
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)

Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples: S01-0.5	Environmental Samples: S02-0.5	Environmental Samples: S03-1	Environmental Samples: S04-1.5 & S06-1.5 (Replicates)	Environmental Samples: S04-1.5 & S06-1.5 (Replicates)	Environmental Samples: S05-1	Field Blanks: AB02	Field Blanks: EB04	Field Blanks: TB04	Lab Blanks	Lab Blanks
Laboratory Sample ID Numbers					294	296	298	300	264	261 4264-2	4263-4	254/257 4263-6	252 4263-5	#5-82193 #1&2-82193 4263	#5-82193 #1&2-82193 4264
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	7-8	70-80	500[a]	13.8J[d]-167J[d]	35,700J[b]	81,500J[b]	<70[b]	14,500J[b]	12,000[b]	<80[b]	NA	<1,000[b]	NA	<1,000	<50
GRPH	0.1-5.3	1-53	100	<0.600-<1.00	750J[b]	1,700J[b]	<53J[b]	2,200J[b]	1,100J[b]	<1J[b]	NA	<50J[b]	<1J[b]	<50	<1
RRPH (Approx.)	10	100	2,000[a]	NA	<100	<100	<100	<100	<100	<100	NA	<100	NA	<1,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<72	<97	<4.03	<70	19.5J	0.49J					
Benzene	0.002-2.0	0.02-20	0.5	<0.030-<0.060	<9	<20	<0.03	<9	0.03J	0.06J	<1[c]	<1	<1	<1	<0.02
Toluene	0.002-2.7	0.02-27		<0.030-<0.060	<12	<27	<0.8	<8	2.4	0.09	<1[c]	<1	<1	<1	<0.02
Ethylbenzene	0.002-1.6	0.02-16		<0.030-<0.060	<7	<13	<1.1	<16	7.1	0.21	<1[c]	<1	<1	<1	<0.02
Xylenes (Total)	0.004-4.4	0.04-44		<0.060-<0.120	<44	<37	<2.1	<37	10J	0.13J	<2[c]	<2	<2	<2	<0.04
HVOC 8010	0.002-0.003	0.02-0.03		NA	<0.03	<0.03	<0.03	<0.02	<0.02	<0.02	NA	<1	<1	<1	<0.02
VOC 8260															
Benzene	0.020	0.045	0.5	<0.030-<0.045	NA	NA	NA	NA	NA	0.047	<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.045		<0.030-<0.045	NA	NA	NA	NA	NA	0.158	<1	<1	<1	<1	<0.020
1,2,4-Trimethylbenzene	0.020	0.045		<0.030-<0.045	NA	NA	NA	NA	NA	0.096	<1	<1	<1	<1	<0.020
Xylenes (Total)	0.020	0.045		<0.060-<0.090	NA	NA	NA	NA	NA	0.556	<2	<2	<2	<2	<0.040
SVOC 8270	0.200	3.50		<0.330-<3.30	NA	NA	NA	NA	NA	<3.50J	NA	<22	NA	<10	<0.200

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					S01-0.5	S02-0.5	S03-1	S04-1.5 & S06-1.5 (Replicates)		S05-1	AB02	EB04	TB04		
Laboratory Sample ID Numbers					284	296	298	300	264	281 4264-2	4263-4	254/257 4263-6	252 4263-5	#5-82193 #1&2-82193 4263	#5-82193 #1&2-82193 4264
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
Pesticides	0.001-0.05	0.01-0.5		<0.005-<0.100	<0.01J-<0.5J	NA	NA	NA	NA	<0.02J-<0.5J	NA	<0.2J-<10J	NA	NA	<0.01J-<0.5J
PCBs	0.01	0.1	10	<0.030-<0.100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	<2	NA	<2	<0.1

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
Matrix: Soil/Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					S07-1.5	SD01	SD02	SD03	SD04	SD05	AB02	EB04	TB04		
Laboratory Sample ID Numbers					280	238	240	242 4264-1	244	246	4263-4	254/257 4263-6	252 4263-5	#5-82193 #1&2-82193 4263	#6-82193 #5-82193 #1&2-82193 4264
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5-10	50-100	500[a]	13.8J[d]-167J[d]	690[b]	17,000J[b]	12,000J[b]	7,900J[b]	300,000J[b]	12,400J[b]	NA	<1,000[b]	NA	<1,000	<50
GRPH	0.1-1.4	1-14	100	<0.600-<1.00	130J[b]	380J[b]	23J[b]	520J[b]	94J[b]	<14J[b]	NA	<50J[b]	<1J[b]	<50	<1
RRPH (Approx.)	10-20	100-200	2,000[a]	NA	<200	<100	<100	450	15,000	6,000	NA	<100	NA	<1,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	22.05J	69.1J	6.85J	89.5J	10.88J	<3.18					
Benzene	0.002	0.02	0.5	<0.030-<0.060	0.05J	4.2J	0.05J	12.8J	1.9J	<0.02	<1[c]	<1	<1	<1	<0.02
Toluene	0.002-0.016	0.02-0.16		<0.030-<0.060	1.6	4.2	0.3	15.8	1.5	<0.16	<1[c]	<1	<1	<1	<0.02
Ethylbenzene	0.002-0.12	0.021.2		<0.030-<0.060	3.4	23.7	2.7	34	0.58	<1.2	<1[c]	<1	<1	<1	<0.02
Xylenes (Total)	0.004-0.018	0.04-1.8		<0.060-<0.120	17J	37J	3.8J	26.8J	7J	<1.8	<2[c]	<2	<2	<2	<0.04
HVOC 8010	0.002-0.02	0.02-0.2		NA	<0.04	<0.03	<0.02	<0.05	<0.02	<0.2	NA	<1	<1	<1	<0.02
VOC 8260															
1,2,4-Trimethylbenzene	0.020	0.200		<0.030-<0.045	NA	NA	NA	0.245	NA	NA	<1	<1	<1	<1	<0.020
1,3,5-Trimethylbenzene	0.020	0.200		<0.030-<0.045	NA	NA	NA	0.507	NA	NA	1	1	1	<1	<0.020
Xylenes (Total)	0.020	0.200		<0.060-<0.090	NA	NA	NA	0.581	NA	NA	<2	<2	<2	<2	<0.040
SVOC 8270	0.200	3.00		<0.330-<3.30	NA	NA	NA	<3.00J	NA	NA	NA	<22	NA	<10	<0.200
PCBs	0.01-0.02	0.1-0.2	10	<0.030-<0.100	<0.2	<0.1	<0.1	<0.2	<0.1	<0.1	NA	<2	NA	<2	<0.1

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
Matrix: Soil/Sediment
Units: mg/kg
METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples						Field Blank	Lab Blanks
					S05-1	SD03					EB04	
Laboratory Sample ID Numbers					4264-2	4264-1					4263-6	4264 4263
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg					µg/L	µg/L
Aluminum	0.35	2		1,500-25,000	3,600	2,700					<100	<100
Antimony	N/A	78-90		<7.8-<230	<90	<78					<100	<100
Arsenic	0.11	7.8-9.0		<4-8.5	<9.0	<7.8					<100	<100
Barium	0.024	1		27-390	130	220					<50	<50
Beryllium	N/A	3.9-4.5		<2.6-6.4	<4.5	<3.9					<50	<50
Cadmium	0.33	3.9-4.5		<3.0-<36	<4.5	<3.9					<50	<50
Calcium	0.69	4		360-59,000	7,800	17,000					<200	<200
Chromium	0.066	1		<4.3-47	7.2	8.3J					<50	<50
Cobalt	N/A	7.8-9.0		<5.1-12	<9.0	<7.8					<100	<100
Copper	0.045	1		<2.7-45	12	17					<50	<50
Iron	0.50	2		5,400-35,000	17,000	20,000					<100	<100
Lead	0.13	2-9.0		<5.1-22	<9.0	26					<100	<100
Magnesium	0.96	4		360-7,400	1,500	2,100					<200	<200
Manganese	0.025	1		25-290	480	1,000					<50	<50
Molybdenum	N/A	3.9-4.5		<2.5-<11	<4.5	<3.9					<50	<50
Nickel	0.11	1		4.2-46	11	9.0					<50	<50

☐ CT&E Data.
N/A Not analyzed.
J Result is an estimate.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
Matrix: Soil/Sediment
Units: mg/kg
METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples						Field Blank	Lab Blanks
					S05-1	SD03					EB04	
Laboratory Sample ID Numbers					4264-2	4264-1					4263-6	4264 4263
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg					µg/L	µg/L
Potassium	23	390-450		<300-2,200	<450	<390					<5,000	<5,000
Selenium	1.2	78-90		<7.8-<170	<90	<78					<100	<100
Silver	0.53	3.9-4.5		<3-<110	<4.5	<3.9					<50	<50
Sodium	0.55	5		<160-680	540	260					<250	<250
Thallium	0.011	0.34-0.44		<0.2-<1.2	<0.44	<0.34					<5	<5
Vanadium	0.036	1		6.3-59	11	11					<50	<50
Zinc	0.16	1		9.2-95	28	36					<50	<50

☐ CT&E Data.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point Matrix: Sediment
Site: Gasoline Storage Area (ST08) Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples		Field Blanks			Lab Blanks	
					SD06	SD07	AB02	EB04	TB04		
Laboratory Sample ID Numbers					248	250	4263-4	254/257	252	#5-82193 #1&2-82193 4263	#6-82193 #1&2-82193
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5	50	500[a]	13.8J[d]-167J[d]	180J[b]	20,800J[b]	NA	<1,000[b]	NA	<1,000	<50
GRPH	1-17	10-170	100	<0.600-<1.00	<10J[b]	<170J[b]	NA	<50J[b]	<1J[b]	<50	<1
RRPH (Approx.)	10	100	2,000[a]	NA	<100	<100	NA	<100	NA	<1,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<8.3	<0.76					
Benzene	0.002-0.12	0.02-1.2	0.5	<0.030-<0.060	<1.2	<0.02	<1[c]	<1	<1	<1	<0.02
Toluene	0.008-0.09	0.08-0.9		<0.030-<0.060	<0.9	<0.08	<1[c]	<1	<1	<1	<0.02
Ethylbenzene	0.015-0.23	0.15-2.3		<0.030-<0.060	<2.3	<0.15	<1[c]	<1	<1	<1	<0.02
Xylenes (Total)	0.051-0.39	0.51-3.9		<0.060-<0.120	<3.9	<0.51	<2[c]	<2	<2	<2	<0.04
HVOC 8010	0.002-0.005	0.02-0.05		NA	<0.05	<0.02	NA	<1	NA	<1	<0.02
PCBs	0.02-0.06	0.2-0.6	10	<0.030-<0.100	<0.2	<0.6	NA	<2	NA	<2	<0.1

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point | Matrix: Soil
Site: Gasoline Storage Area (ST08) | Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					2S08-1.5	2S09 & 2S18 (Replicates)		2S10-1	2S11-1	2S12	AB02	2EB05	2TB05		
Laboratory Sample ID Numbers					1816	1818	1829	1819	1820	1822	4263-4	1844	1845	#1&2-9793 4263	#5-9693 #1&2-9793
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	6-12	60-120	500[a]	13.8J[d]-167J[d]	<110[b]	<80[b]	<120[b]	<70[b]	<100[b]	<80[b]	NA	NA	NA	NA	<50
GRPH	0.2	2	100	<0.600-<1.00	<2J[b]	NA	NA	NA	NA	25J[b]	NA	<50J[b]	<50J[b]	<50	<1
RRPH (Approx.)	14-24	140-240	2,000[a]	NA	<240	<160	<240	<140	<200	<160	NA	NA	NA	NA	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<0.16	NA	NA	NA	NA	2J					
Benzene	0.003-0.004	0.03-0.04	0.5	<0.030-<0.060	<0.04	NA	NA	NA	NA	<0.03	<1[c]	<1	<1	<1	<0.02
Toluene	0.003-0.004	0.03-0.04		<0.030-<0.060	<0.04	NA	NA	NA	NA	<0.03	<1[c]	<1	<1	<1	<0.02
Ethylbenzene	0.003-0.006	0.03-0.06		<0.030-<0.060	<0.06	NA	NA	NA	NA	1	<1[c]	<2	<1	<1	<0.02-<0.03
Xylenes (Total)	0.006-0.02	0.06-0.2		<0.060-<0.120	<0.2	NA	NA	NA	NA	1J	<2[c]	<5	<2	<2	<0.04-<0.09

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point   Matrix: Soil
Site: Gasoline Storage Area (ST08)   Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					2S13-0.5	2S14-1	2S15-2.5	2S16-1	2S17-1.5	2S18-2.5	AB02	2EB05	2TB05		
Laboratory Sample ID Numbers					1823	1824	1825	1826	1827 1828 4628-11	1834	4263-4	1844 4628-8	1845 4628-5	#1&2-9793 4263	#5-9693 #1&2-9793 4628
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	6-11	60-110	500[a]	13.8J[d]-167J[d]	1,900J[b]	<80[b]	1,500J[b]	<110[b]	<70[b]	<60[b]	NA	NA	NA	NA	<50
GRPH	0.2	2	100	<0.600-<1.00	NA	NA	NA	NA	97J[b]	NA	NA	<50J[b]	<50J[b]	<50	<1
RRPH (Approx.)	12-24	120-240	2,000[a]	NA	<160	<160	<120	<240	<140	<140	NA	NA	NA	NA	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	NA	NA	NA	NA	9.9J	NA					
Benzene	0.02	0.2	0.5	<0.030-<0.060	NA	NA	NA	NA	0.2J	NA	<1[c]	<1	<1	<1	<0.02
Toluene	0.02	0.2		<0.030-<0.060	NA	NA	NA	NA	0.7	NA	<1[c]	<1	<1	<1	<0.02
Ethylbenzene	0.02	0.2		<0.030-<0.060	NA	NA	NA	NA	0.7	NA	<1[c]	<2	<1	<1	<0.02-<0.03
Xylenes (Total)	0.04	0.4		<0.060-<0.120	NA	NA	NA	NA	8.3J	NA	<2[c]	<5	<2	<2	<0.04-<0.09
VOC 8260															
sec-Butylbenzene	0.020	0.200		<0.030-<0.045	NA	NA	NA	NA	0.346	NA	<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.200		<0.030-<0.045	NA	NA	NA	NA	0.793	NA	<1	<1	<1	<1	<0.020
Isopropylbenzene	0.020	0.200		<0.030-<0.045	NA	NA	NA	NA	0.525	NA	<1	<1	<1	<1	<0.020
p-Isopropyltoluene	0.020	0.200		<0.030-<0.045	NA	NA	NA	NA	0.273	NA	<1	<1	<1	<1	<0.020
Naphthalene	0.020	0.200		<0.030-<0.045	NA	NA	NA	NA	1.99	NA	<1	<1	<1	<1	<0.020
n-Propylbenzene	0.020	0.200		<0.030-<0.045	NA	NA	NA	NA	2.19B	NA	<1	1.6	<1	<1	<0.020

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
B The analyte was detected in the associated blank.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					2S13-0.5	2S14-1	2S15-2.5	2S16-1	2S17-1.5	2S19-2.5	AB02	2EB05	2TB05		
Laboratory Sample ID Numbers					1823	1824	1825	1826	1827 1828 4628-11	1834	4263-4	1844 4628-6	1845 4628-5	4628 4263	4628
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
Toluene	0.020	0.200		<0.030-<0.045	NA	NA	NA	NA	0.940	NA	<1	1.6	<1	<1	<0.020
1,2,4-Trimethylbenzene	0.020	0.200		<0.030-<0.045	NA	NA	NA	NA	27.4	NA	<1	<1	<1	<1	<0.020
1,3,5-Trimethylbenzene	0.020	0.200		<0.030-<0.045	NA	NA	NA	NA	24.7	NA	<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.400		<0.060-<0.090	NA	NA	NA	NA	22.2	NA	<2	<2	<2	<2	<0.040

☐ CT&E Data.
NA Not analyzed.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point | Matrix: Sediment
Site: Gasoline Storage Area (ST08) | Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples					Field Blank	Lab Blanks	
					2SD08	2SD09				EB04		
Laboratory Sample ID Numbers					1814	1815				254	#5-82193	#5-9693
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg				µg/L	µg/L	mg/kg
DRPH	20	200	500[a]	13.8J[d]-167J[d]	<200[b]	<200[b]				<1,000[b]	<1,000	<50
RRPH (Approx.)	40	400	2,000[a]	<0.600-<1.00	<400	<400				<1,000	<1,000	<100

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)

Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples			Field Blanks			Lab Blanks
					SW01	SW02	SW03	AB02	EB04	TB04	
Laboratory Sample ID Numbers					218/228 4263-1	230/233	234/237	4263-4	254/257 4263-6	252 4263-5	#5-82193 #1&2-82193 4263
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
DRPH	100	1,000		392[ad]-457J[ad]	<1,000J[b]	<1,000[b]	<1,000[b]	NA	<1,000[b]	NA	<1,000
GRPH	5	50		<20	<50J[b]	<50J[b]	<50J[b]	NA	<50J[b]	<1J[b]	<50
RRPH (Approx.)	100	1,000		NA	<1,000	<1,000	<1,000	NA	<1,000	NA	<1,000
BTEX (8020/8020 Mod.)											
Benzene	01	1	5	<1	<1	<1	<1	1[c]	<1	<1	<1
Toluene	0.1	1	1,000	<1	<1	<1	<1	1[c]	<1	<1	<1
Ethylbenzene	0.1	1	700	<1	<1	<1	<1	1[c]	<1	<1	<1
Xylenes (Total)	0.2	2	10,000	<2	<2	<2	<2	2[c]	<2	<2	<2
HVOC 8010	0.1	1		NA	<1	<1	<1	NA	<1	<1	<1
VOC 8260											
1,2-Dichloroethane	1	1	5	<1	1	NA	NA	<1	<1	<1	<1
Methylene chloride	1	1	5	<1	1B	NA	NA	2.8	1.5	<1	<1

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
B The analyte was detected in the associated blank.
J Result is an estimate.
a Total petroleum hydrocarbons in these water samples exceed the 15 µg/L stated for fresh water in ADEC's Water Quality Criteria 18AAC70 (ADEC 1989).
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples			Field Blanks			Lab Blanks
					SW01	SW02	SW03	AB02	EB04	TB04	
Laboratory Sample ID Numbers					218/228 4263-1	230/233	234/237	4263-4	254/257 4263-6	252 4263-5	4263
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
SVOC 8270											
bis (2-Ethylhexyl) phthalate	10	22	6	<10	48	NA	NA	NA	<22	NA	<10
PCBs	0.2	2	0.5	<1-<2	<2	<2	<2	NA	<2	NA	<2
TOC	5,000	5,000		6,700-14,400	32,300	NA	NA	NA	NA	NA	<5,000
TSS	100	200		6,000-9,000	12,000	NA	NA	NA	NA	NA	<200
TDS	10,000	10,000		212,000-352,000	692,000	NA	NA	NA	NA	NA	<10,000

□ CT&E Data.
■ F&B Data.
NA Not analyzed.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample					Field Blank	Lab Blank
					SW01					EB04	
Laboratory Sample ID Numbers					4263-1					4263-6	4263
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L					µg/L	µg/L
Aluminum	17.4	100		<100-350 (<100-340)	<100 (<100)					<100	<100 (<100)
Antimony	N/A	100	6	<100 (<100)	<100 (<100)					<100	<100 (<100)
Arsenic	5.3	100	50	<100 (<100)	<100 (<100)					<100	<100 (<100)
Barium	1.2	50	2,000	<50-93 (<50-91)	220 (210)					<50	<50 (<50)
Beryllium	N/A	50	4	<50 (<50)	<50 (<50)					<50	<50 (<50)
Cadmium	1.7	50	5	<50 (<50)	<50 (<50)					<50	<50 (<50)
Calcium	34.5	200		4,500-88,000 (4,100-86,000)	82,000 (83,000)					<200	<200-378 (378)
Chromium	3.29	50	100	<50 (<50)	<50 (<50)					<50	<50 (<50)
Cobalt	N/A	100		<100 (<100)	<100 (<100)					<100	<100 (<100)
Copper	2.3	50	1,300	<50 (<50)	<50 (<50)					<50	<50 (<50)
Iron	25	100		180-2,800 (<100-1,600)	3,100 (630)					<100	<100 (<100)

☐ CT&E Data.
N/A Not available.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample					Field Blank	Lab Blank
					SW01					EB04	
Laboratory Sample ID Numbers					4263-1					4263-6	4263
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L					µg/L	µg/L
Lead	6.6	100	15	<100 (<100)	<100 (<100)					<100	<100 (<100)
Magnesium	47.8	50		<5,000-53,000 (2,600-54,000)	29,000 (31,000)					<200	<200 (<200)
Manganese	1.24	50		<50-510 (<50-120)	290 (280)					<50	<50 (<50)
Molybdenum	N/A	50		<50 (<50)	<50 (<50)					<50	<50 (<50)
Nickel	5.5	50	100	<50 (<50)	<50 (<50)					<50	<50 (<50)
Potassium	1,154	5,000		<5,000 (<5,000)	<5,000 (<5,000)					<5,000	<5,000 (<5,000)
Selenium	62.4	100	50	<100 (<100)	<100 (<100)					<100	<100 (<100)
Silver	2.6	50	50	<50 (<50)	<50 (<50)					<50	<50 (<50)
Sodium	27.7	250		8,400-410,000 (8,200-450,000)	120,000 (120,000)					<250	<250 (<250)
Thallium	0.57	5	2	<5 (<5)	<5 (<5)					<5	<5 (<5)
Vanadium	1.8	50		<50 (<50)	<50 (<50)					<50	<50 (<50)

☐ CT&E Data.
N/A Not available.

TABLE G-8. GASOLINE STORAGE AREA ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Gasoline Storage Area (ST08)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample					Field Blank	Lab Blank
					SW01					EB04	
Laboratory Sample ID Numbers					4263-1					4263-6	4263
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L					µg/L	µg/L
Zinc	8.2	50		<50-160 (<50)	<50 (<50)					<50	<50 (<50)

☐ CT&E Data.
N/A Not available.

TABLE G-9. GARAGE ANALYTICAL DATA SUMMARY

Installation: Oliktok Point
Site: Garage (SS10)

Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					S01	S02	S03	S04	S05 & S06 (Replicates)		AB02	EB04	TB04		
Laboratory Sample ID Numbers					282	284 4264-3	286	288	290	292	4263-4	254/257 4263-6	252 4263-5	#5-82193 #1&2-82193 4263	#5-82193 #1&2-82193 4264
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5	50	500[a]	13.8J[d]-167J[d]	20,000J[b]	54,000J[b]	75,000J[b]	35,600J[b]	950J[b]	70J[b]	NA	<1,000[b]	NA	<1,000	<50
GRPH	0.1-5	1-50	100	<0.600-<1.00	<1[b]	130J[b]	<400J[b]	<25J[b]	260J[a]	240J[b]	NA	<50J[b]	<1J[b]	<50	<1
RRPH (Approx.)	10	100	2,000[a]	NA	<100	52,000	50,000	10,000	<100	<100	NA	<1,000	NA	<1,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<0.10	12.64J	<25.64	<13.64	3.7J	8.34J					
Benzene	0.002-0.004	0.02-0.04	0.5	<0.030-<0.060	<0.02	<0.02	<0.04	<0.04	1.1J	0.54J	<1[c]	<1	<1	<1	<0.02
Toluene	0.002-0.06	0.02-0.6		<0.030-<0.060	<0.02	0.04	<0.6	<0.4	0.6	1.8	<1[c]	<1	<1	<1	<0.02
Ethylbenzene	0.002-0.22	0.02-2.2		<0.030-<0.060	<0.02	8.5	<0.3	<2.2	0.5	3.6	<1[c]	<1	<1	<1	<0.02
Xylenes (Total)	0.004-2.3	0.04-23		<0.060-<0.120	<0.04	3.1J	<23	<11	1.5J	2.5J	<2[c]	<2	<2	<2	<0.04
HVOC 8010															
Tetrachloroethene	0.002-1.8	0.02-18		NA	<0.02	5.2J	<0.02	<18	<0.02	<0.02	NA	<1	NA	<1	<0.02
VOC 8260	0.020	0.020		<0.030-<0.045	NA	<0.020	NA	NA	NA	NA	<1-2.8	<1-1.5	<1	<1	<0.020
SVOC 8270															
Fluoranthene	0.200	2.200		<0.330-<3.30	NA	6.77	NA	NA	NA	NA	NA	<22	NA	<10	<0.200
Pyrene	0.200	2.200		<0.330-<3.30	NA	5.32	NA	NA	NA	NA	NA	<22	NA	<10	<0.200
bis (2-Ethylhexyl) phthalate	0.200	2.200	50	<0.330-<3.30	NA	5.53	NA	NA	NA	NA	NA	<22	NA	<10	<0.200
PCBs															
Aroclor 1254	0.01	0.1	10	<0.030-<0.100	<0.1	<0.1	<0.1	3J	<0.1	<0.1	NA	<2	NA	<2	<0.1

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-9. GARAGE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Garage (SS10)

Matrix: Soil
Units: mg/kg

METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample					Field Blank	Lab Blanks
					S02					EB04	
Laboratory Sample ID Numbers					4264-3					4263-6	4263 4264
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg					µg/L	µg/L
Aluminum	0.35	2		1,500-25,000	2,100					<100	<100
Antimony	N/A	55		<7.8-<230	<55					<100	<100
Arsenic	0.11	5.5		<4.9-8.5	<5.5					<100	<100
Barium	0.024	1		27-390	130					<50	<50
Beryllium	N/A	2.8		<2.6-6.4	<2.8					<50	<50
Cadmium	0.33	2.8		<3.0-<36	<2.8					<50	<50
Calcium	0.69	4		360-59,000	5,600					<200	<200-378
Chromium	0.066	1		<4.3-47	7.6J					<50	<50
Cobalt	N/A	5.5		<5.1-12	<5.5					<100	<100
Copper	0.045	1		<2.7-45	18					<50	<50
Iron	0.50	2		5,400-35,000	7,300					<100	<100
Lead	0.13	2		<5.1-22	48					<100	<100
Magnesium	0.96	4		360-7,400	1,100					<200	<200
Manganese	0.025	1		25-290	94					<50	<50
Molybdenum	N/A	2.8		<2.5-<11	<2.8					<50	<50
Nickel	0.11	1		4.2-46	8.1					<50	<50

☐ CT&E Data.
N/A Not available.
J Result is an estimate.

TABLE G-9. GARAGE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Garage (SS10)
Matrix: Soil
Units: mg/kg
METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample					Field Blank	Lab Blanks
					S02					EB04	
Laboratory Sample ID Numbers					4264-3					4263-6	4263 4264
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg					µg/L	µg/L
Potassium	23	100		<300-2,200	370					<5,000	<5,000
Selenium	1.2	55		<7.8-<170	<55					<100	<100
Silver	0.53	2.8		<3-<110	<2.8					<50	<50
Sodium	0.55	5		<160-<680	200					<250	<250
Thallium	0.011	0.26		<0.2-<1.2	<0.26					<5	<5
Vanadium	0.036	1		6.3-59	8.5					<50	<50
Zinc	0.16	1		9.2-95	130					<50	<50

☐ CT&E Data.

TABLE G-9. GARAGE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Garage (SS10)
Matrix: Soil/Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					S07-2	S08-1	S09-1.5	S10-4.5	S11-4.5	SD01	AB02	EB04	TB04		
Laboratory Sample ID Numbers					266	268	270	272	274	277/278	4263-4	254/257 4263-6	252 4263-5	#1&2-82193 #5-82193 4263	#5-82193 #1&2-82193
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	5-150	50-1,500	500[a]	13.8J[d]-167J[d]	4,800[b]	2,300[b]	3,300[b]	<60[b]	2,100[b]	<1,500[b]	NA	<1,000[b]	NA	<500	<50
GRPH	0.1-130	1-1,300	100	<0.600-<1.00	1,300J[b]	820J[b]	1,500J[b]	<440J[b]	1,200J[b]	<1,300J[b]	NA	<50J[b]	<1J[b]	<50	<1
RRPH (Approx.)	10	100	2,000[a]	NA	170	<120	120	<100	<100	1,500	NA	<1,000	NA	<1,000	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	<19.5J	<23.36J	26.5J	<0.83J	38.3J	<0.80J					
Benzene	0.002-0.27	0.02-2.7	0.5	<0.030-<0.060	<2.7J	<0.36J	3.5J	<0.14J	0.12J	<0.03J	<1[c]	<1	<1	<1	<0.02
Toluene	0.002-0.38	0.02-3.8		<0.030-<0.060	<3.8J	<1.1J	4.5	<0.09J	0.88	<0.1J	<1[c]	<1	<1	<1	<0.02
Ethylbenzene	0.002-0.42	0.02-4.2		<0.030-<0.060	<4.2J	<2.9J	6.5	<0.2J	6.3	<0.32J	<1[c]	<1	<1	<1	<0.02
Xylenes (Total)	0.004-1.9	0.04-19		<0.060-<0.120	<8.8J	<19J	12J	<0.4J	31J	<0.35J	<2[c]	<2	<2	<2	<0.04
HVOC 8010	0.002	0.02		NA	<7.6J	<0.02	<0.02	<0.02	<0.02	<0.02	NA	<1	NA	<1	<0.02
PCBs	0.01-3	0.1-30	10	<0.030-<0.100	<0.1	<0.1	<0.1	<0.1	<0.1	<30	NA	<2	NA	<2	<0.1

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-9. GARAGE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Garage (SS10)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples				Field Blanks			Lab Blanks	
					2S12-1 & 2S15-1 (Replicates)		2S13-1	2S14	AB02	2EB05	2TB05		
Laboratory Sample ID Numbers					1810 4628-1	1813 4628-4	1811 4628-2	1812 4628-3	4263-4	4628-6	4628-5	4263 4628	#5-9693 4628
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	6-7	60-70	500[a]	13.8J[d]-167J[d]	<60[b]	<70[b]	<60[b]	6,800J[b]	NA	NA	NA	NA	<50
RRPH (Approx.)	12-34	120-340	2,000[a]	NA	<120	<340	<120	<200	NA	NA	NA	NA	<1,000
VOC 8260	0.020	0.025-0.400		<0.030-<0.045	<0.030	<0.030	<0.025	<0.400	<1-2.8	<1-2.7	<1-6.8	<1	<0.020

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH concentrations reported for these samples are equivalent to diesel range organics (DRO) as defined by ADEC.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-9. GARAGE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point Matrix: Surface Water
Site: Garage (SS10) Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Sample				Field Blanks			Lab Blanks
					SW01				AB02	EB04	TB04	
Laboratory Sample ID Numbers					260/276 4263-7 4264-4				4263-4	254/257 4263-6	252 4263-5	#5-82193 #1&2-82193 4264 4263
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L				µg/L	µg/L	µg/L	µg/L
DRPH	100	1,000		392^{ad}-$457J^{ad}$	<1,000[b]				NA	<1,000[b]	NA	<1,000
GRPH	5	50		<20	<50J[b]				NA	<50J[b]	<1J[b]	<50
RRPH (Approx.)	100	1,000		NA	<1,000				NA	<1,000	NA	<1,000
BTEX (8020/8020 Mod.)												
Benzene	0.1	1	5	<1	<1				<1[c]	<1	<1	<1
Toluene	0.1	1	1,000	<1	<1				<1[c]	<1	<1	<1
Ethylbenzene	0.1	1	700	<1	<1				<1[c]	<1	<1	<1
Xylenes (Total)	0.2	2	10,000	<2	<2				<2[c]	<2	<2	<2
VOC 8260	1	1		<1	<1				<1-2.8	<1-1.5	<1	<1
SVOC 8270	10	22		<10	<22				NA	<22	NA	<10

□ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a Total petroleum hydrocarbons in these water samples exceed the 15 µg/L stated for fresh water in ADEC's Water Quality Criteria 18AAC70 (ADEC 1989).
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-9. GARAGE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Garage (SS10)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blanks
					SW01						EB04	
Laboratory Sample ID Numbers					4264-4						4263-6	4264 4263
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Aluminum	17.4	100		<100-350 (<100-340)	<100 (<100)						<100	<100 (<100)
Antimony	N/A	100	6	<100 (<100)	<100 (<100)						<100	<100 (<100)
Arsenic	5.3	100	50	<100 (<100)	<100 (<100)						<100	<100 (<100)
Barium	1.2	50	2,000	<50-93 (<50-91)	290 (260)						<50	<50 (<50)
Beryllium	N/A	50	4	<50 (<50)	<50 (<50)						<50	<50 (<50)
Cadmium	1.7	50	5	<50 (<50)	<50 (<50)						<50	<50 (<50)
Calcium	34.5	200		4,500-88,000 (4,100-86,000)	77,000 (75,000)						<200	<200-378 (378)
Chromium	3.29	50	100	<50 (<50)	<50 (<50)						<50	<50 (<50)
Cobalt	N/A	100		<100 (<100)	<100 (<100)						<100	<100 (<100)
Copper	2.3	50	1,300	<50 (<50)	<50 (<50)						<50	<50 (<50)
Iron	25	100		180-2,800 (<100-1,600)	2,200 (230)						<100	<100 (<100)

☐ CT&E Data.
N/A Not available.

TABLE G-9. GARAGE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Garage (SS10)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blanks
					SW01						EB04	
Laboratory Sample ID Numbers					4264-4						4263-6	4264 4263
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Lead	6.6	100	15	<100 (<100)	<100 (<100)						<100	<100 (<100)
Magnesium	47.8	200		<5,000-53,000 (2,600-54,000)	29,000 (27,000)						<200	<200 (<200)
Manganese	1.24	50		<50-510 (<50-120)	120 (<50)						<50	<50 (<50)
Molybdenum	N/A	50		<50 (<50)	<50 (<50)						<50	<50 (<50)
Nickel	5.5	50	100	<50 (<50)	<50 (<50)						<50	<50 (<50)
Potassium	1,154	5,000		<5,000 (<5,000)	<5,000 (<5,000)						<5,000	<5,000 (<5,000)
Selenium	62.4	100	50	<100 (<100)	<100 (<100)						<100	<100 (<100)
Silver	2.6	50	50	<50 (<50)	<50 (<50)						<50	<50 (<50)
Sodium	27.7	250		8,400-410,000 (8,200-450,000)	100,000 (87,000)						<250	<250 (<250)
Thallium	0.57	5	2	<5 (<5)	<5 (<5)						<5	<5 (<5)
Vanadium	1.8	50		<50 (<50)	<50 (<50)						<50	<50 (<50)

☐ CT&E Data.
N/A Not available.

TABLE G-9. GARAGE ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Garage (SS10)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Sample						Field Blank	Lab Blanks
					SW01						EB04	
Laboratory Sample ID Numbers					4264-4						4263-6	4264 4263
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Zinc	8.2	50		<50-160 (<50)	<50 (<50)						<50	<50 (<50)

☐ CT&E Data.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY

Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)

Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					SD01 & SD09 (Replicates)		SD02	SD03	SD04	SD05	AB01	EB02	TB02		
Laboratory Sample ID Numbers					4217-6 4209-8	4209-10 4218-1	4217-9	4217-10	4217-11	4209-9 4217-12	4209-7 4214-6	4209-6 4214-5	4209-11 4214-7	4209 4214	4209 4218 4217
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	13.8J[e]-167J[e]	1,360	2,990	63.6[d]	1,660	68.8[c]	573	NA	NA	NA	NA	<4.00
GRPH	0.400	0.600	100	<0.600-<1.00	281	249	8.18	389	<0.600	53.7	NA	<20	NA	<20	<0.400
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	5.614	23.288	0.154	9.402	<0.15	0.455					
Benzene	0.020	0.025-0.135	0.5	<0.030-<0.060	0.025	0.038	<0.025	<0.135	<0.030	<0.020	<1	<1	<1	<1	<0.020
Toluene	0.020	0.025-0.135		<0.030-<0.060	0.458	1.75	<0.025	0.872	<0.030	<0.020	<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.025-0.135		<0.030-<0.060	0.961	2.85	0.029	2.02	<0.030	0.126	<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.05-0.270		<0.060-<0.120	4.17	18.65	0.125	6.51	<0.060	0.329	<2	<2	<2	<2	<0.040
VOC 8010	0.020	0.020-0.135		<0.030-<0.060	<0.020	<0.020	<0.025	<0.135	<0.030	<0.020	<1	<1	<1	<1	<0.020
VOC 8260															
n-Butylbenzene	0.020	0.230-0.275		<0.030-<0.045	8.07	5.18	NA	NA	NA	<0.230	<1	<1	<1	<1	<0.020
sec-Butylbenzene	0.020	0.230-0.275		<0.030-<0.045	3.49	2.14	NA	NA	NA	<0.230	<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.230-0.275		<0.030-<0.045	2.65	1.63	NA	NA	NA	<0.230	<1	<1	<1	<1	<0.020
Isopropylbenzene	0.020	0.230-0.275		<0.030-<0.045	2.42	1.38	NA	NA	NA	<0.230	<1	<1	<1	<1	<0.020
p-Isopropylbenzene	0.020	0.230-0.275		<0.030-<0.045	3.59	2.39	NA	NA	NA	<0.230	<1	<1	<1	<1	<0.020
Naphthalene	0.020	0.230-0.275		<0.030-<0.045	9.30	6.66	NA	NA	NA	<0.230	<1	<1	<1	<1	<0.020
n-Propylbenzene	0.020	0.230-0.275		<0.030-<0.045	5.49	3.15	NA	NA	NA	<0.230	<1	<1	<1	<1	<0.020
Toluene	0.020	0.230-0.275		<0.030-<0.045	1.99	1.30	NA	NA	NA	<0.230	<1	<1	<1	<1	<0.020

☐ CT&E Data.
NA Not analyzed.
J Result is an estimate.
a The action level for DRPH is based on conversations with ADEC; a final action level has not yet been determined.
c The laboratory reported that 32.3 mg/kg of the EPH pattern in this sample was not consistent with a middle distillate fuel.
d The laboratory reported that 40.3 mg/kg of the EPH pattern in this sample was not consistent with a middle distillate fuel.
e The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples						Field Blanks			Lab Blanks	
					SD01 & SD09 (Replicates)		SD02	SD03	SD04	SD05	AB01	EB02	TB02		
Laboratory Sample ID Numbers					4217-6 4209-8	4209-10 4218-1	4217-9	4217-10	4217-11	4209-9 4217-12	4209-7 4214-6	4209-6 4214-5	4209-11 4214-7	4209 4214	4209 4218 4217
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
1,2,4-Trimethyl-benzene	0.020	0.230-0.275		<0.030-<0.045	21.3	13.9	NA	NA	NA	<0.230	<1	<1	<1	<1	<0.020
1,3,5-Trimethyl-benzene	0.020	0.230-0.275		<0.030-<0.045	9.84	6.30	NA	NA	NA	<0.230	<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.460-0.550		<0.060-<0.090	18.29	11.70	NA	NA	NA	<0.460	<2	<2	<2	<2	<0.040
SVOC 8270															
Benzyl Alcohol	0.200	0.240-0.260		<0.330-<3.30	2.50	<0.240	NA	NA	NA	<2.00	NA	<10	NA	<10	<0.200
di-n-Butylphthalate	0.200	0.240-0.260	8,000	<0.330-<3.30	0.337	0.582	NA	NA	NA	0.701	NA	<10	NA	<10	<0.200
bis (2-Ethylhexyl) phthalate	0.200	0.240-0.260	50	<0.330-<3.30	0.504	0.425	NA	NA	NA	0.451	NA	<10	NA	<10	<0.200
Naphthalene	0.200	0.240-0.260		<0.330-<3.30	<0.260	0.852	NA	NA	NA	<0.230	NA	<10	NA	<10	<0.200
2-Methyl naphthalene	0.200	0.240-0.260		<0.330-<3.30	<0.260	2.23	NA	NA	NA	<0.230	NA	<10	NA	<10	<0.200
Pesticides	0.0010	0.001-0.035		<0.005-<0.100	<0.007-<0.035	<0.001-<0.030	NA	NA	NA	<0.002-<0.020	NA	NA	NA	NA	<0.001-<0.010
PCBs															
Aroclor 1254	0.020	0.020-0.035	10	<0.030-<0.100	<0.035	<0.030	0.029	0.030	0.020	<0.020	NA	NA	NA	NA	<0.01

☐ CT&E Data.
NA Not analyzed.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
Matrix: Sediment
Units: mg/kg

METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples							Field Blank	Lab Blank
					SD01 & SD09 (Replicates)		SD05					EB02	
Laboratory Sample ID Numbers					4210-4	4210-8	4210-7					4210-3	4210
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg					µg/L	µg/L
Aluminum	0.35	2		1,500-25,000	2,600	1,400	1,400					<100	<100
Antimony	N/A	56-68		<7.8-<230	<68	<56	<60					<100	<100
Arsenic	0.11	5.6-6.8		<4.9-8.5	<6.8	<5.6	<6.0					<100	<100
Barium	0.024	1		27-390	170	110	120					<50	<50
Beryllium	N/A	2.8-3.4		<2.6-6.4	<3.4	<2.8	<3.0					<50	<50
Cadmium	0.33	2.8-3.4		<3.0-<36	<3.4	<2.8	<3.0					<50	<50
Calcium	0.69	4		360-59,000	9,000	4,000	5,800					230	<200
Chromium	0.066	1		<4.3-47	6.0	3.2	3.2					<50	<50
Cobalt	N/A	5.6-6.8		<5.1-12	<6.8	<5.6	<6.0					<100	<100
Copper	0.045	1		<2.7-45	7.8	8.4	16					<50	<50
Iron	0.50	2		5,400-35,000	9,500	7,100	7,400					<100	<100
Lead	0.13	2-6.0		<5.1-22	18	12	<6.0					<100	<100
Magnesium	0.96	4		360-7,400	1,800	810	580					<200	<200
Manganese	0.025	1		25-290	150	110	79					<50	<50
Molybdenum	N/A	2.8-3.4		<2.5-<11	<3.4	<2.8	<3.0					<50	<50
Nickel	0.11	1		4.2-46	8.5	6.9	5.2					<50	<50

☐ CT&E Data.
N/A Not available.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
Matrix: Sediment
Units: mg/kg

METALS ANALYSES

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples							Field Blank	Lab Blank
					SD01 & SD09 (Replicates)		SD05					EB02	
Laboratory Sample ID Numbers					4210-4	4210-8	4210-7					4210-3	4210
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg					µg/L	µg/L
Potassium	23	100-300		<300-2,200	450	<280	<300					<5,000	<5,000
Selenium	1.2	5.6-6.8		<7.8-<170	<6.8	<5.6	<6.0					<100	<100
Silver	0.53	2.8-3.4		<3-<110	<3.4	<2.8	<3.0					<50	<50
Sodium	0.55	5		<160-680	240	200	130					570	<250
Thallium	0.011	0.29-0.33		<0.2-<1.2	<0.33	<0.29	<0.29					<5	<5
Vanadium	0.036	1		6.3-59	9.5	6.7	7.2					<50	<50
Zinc	0.16	1		9.2-95	35	32	110					<50	<50

☐ CT&E Data.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
Matrix: Sediment
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples				Field Blanks			Lab Blanks	
					SD06	SD07	SD08		AB01	EB02	TB02		
Laboratory Sample ID Numbers					4217-13	4217-14	4217-15		4209-7 4214-6	4214-5	4209-11 4214-7	4209 4214	4217
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	4.00	4.00	500[a]	13.8J[d]-167J[d]	15.5[c]	20.9[c]	142[c]		NA	NA	NA	NA	<4.00
GRPH	0.400	0.400	100	<0.600-<1.00	0.625	1.29	1.89		NA	<20	NA	<20	<0.400
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	0.098	<0.125	<0.125						
Benzene	0.020	0.025	0.5	<0.030-<0.060	<0.025	<0.025	<0.025		<1	<1	<1	<1	<0.020
Toluene	0.020	0.025		<0.030-<0.060	0.098	<0.025	<0.025		<1	<1	<1	<1	<0.020
Ethylbenzene	0.020	0.025		<0.030-<0.060	<0.025	<0.025	<0.025		<1	<1	<1	<1	<0.020
Xylenes (Total)	0.040	0.050		<0.060-<0.120	<0.050	<0.050	<0.050		<2	<2	<2	<2	<0.040
VOC 8010	0.020	0.025		<0.030-<0.060	<0.025	<0.025	<0.025		<1	<1	<1	<1	<0.020
PCBs													
Aroclor 1254	0.020	0.020-0.050	10	<0.030-<0.100	0.045	<0.020	<0.50		NA	NA	NA	NA	<0.020

☐ CT&E Data.
NA Not analyzed.
J Result is an estimate.
a The action level for DRPH is based on conversations with ADEC; a final action level has not yet been determined.
c The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
Matrix: Soil
Units: mg/kg

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples 2S01	2S02	2S03 & 2S07 (Replicates)		2S04	2S05	2S06	Field Blanks AB02	2EB05	2TB05	Lab Blanks	
Laboratory Sample ID Numbers					1835	1836	1838	1843	1839	1840	1842	4263-4	1844	1848	#1&2-9793	#5-9693 #1&2-9793
ANALYSES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	µg/L	µg/L	µg/L	mg/kg
DRPH	6-7	60-70	500[a]	13.8J[d]-167J[d]	4,700J[b]	220J[b]	<60[b]	<60[b]	<60[b]	<70[b]	120J[b]	NA	NA	NA	NA	<50
GRPH	0.1	1	100	<0.600-<1.00	NA	47J[b]	NA	NA	NA	<1J[b]	NA	NA	<50J[b]	<50J[b]	<50	<1
RRPH (Approx.)	14-16	140-160	2,000[a]	NA	<160	<140	<140	<160	<140	<160	<160	NA	NA	NA	NA	<100
BTEX (8020/8020 Mod.)			10 Total BTEX	<0.150-<0.300	NA	3.4J	NA	NA	NA	<0.16	NA					
Benzene	0.002	0.02	0.5	<0.030-<0.060	NA	<0.02	NA	NA	NA	<0.02	NA	<1[c]	<1	<1	<1	<0.02
Toluene	0.002	0.02		<0.030-<0.060	NA	<0.02	NA	NA	NA	<0.02	NA	<1[c]	<1	<1	<1	<0.02
Ethylbenzene	0.003	0.03		<0.030-<0.060	NA	1.2	NA	NA	NA	<0.03	NA	<1[c]	<2	<1	<1	<0.02-<0.03
Xylenes (Total)	0.009	0.09		<0.060-<0.120	NA	2.2J	NA	NA	NA	<0.09	NA	<2[c]	<5	<2	<2	<0.04-<0.09

☐ CT&E Data.
▩ F&B Data.
NA Not analyzed.
J Result is an estimate.
a The action levels for DRPH and RRPH are based on conversations with ADEC; final action levels have not yet been determined.
b DRPH and GRPH concentrations reported for these samples are equivalent to diesel and gasoline range organics (DRO and GRO) as defined by ADEC.
c BTEX determined by 8260 method analysis.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point   Matrix: Surface Water
Site: Old Sewage Area Petroleum Spill (SS11)   Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples SW01	SW02	SW03 & SW04 (Duplicates)		Field Blanks AB01	EB02	TB02	Lab Blanks
Laboratory Sample ID Numbers					4214-1	4214-2	4209-4 4210-1 4214-3	4209-5 4210-2 4214-4	4209-7 4214-6	4209-6 4214-5	4209-11 4214-7	4209 4210 4214
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
DRPH	100	100		392[ad]-457J[ad]	417[ad]	416[ad]	1,030J[ad]	1,110J[ad]	NA	NA	NA	<100
GRPH	20	20		<20	<20	<20	142[a]	134[a]	NA	<20	NA	<20
BTEX (8020/8020 Mod.)												
Benzene	1	1	5	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	1	1	1,000	<1	<1	<1	<1	5.3	<1	<1	<1	<1
Ethylbenzene	1	1	700	<1	<1	<1	<1	<1	<1	<1	<1	<1
Xylenes (Total)	2	2	10,000	<2	<2	<2	5.6[c]	7.7	<2	<2	<2	<2
VOC 8010												
1,2-Dichloroethane	1	1	5	<1	<1	<1	<1J	3.3J	<1	<1	<1	<1
VOC 8260												
1,4-Dichlorobenzene	1	1		<1	NA	NA	1.1	1.1	<1	<1	<1	<1
1,2-Dichloroethane	1	1	5	<1	NA	NA	<1.0J	1.5J	<1	<1	<1	<1
p-Isopropyltoluene	1	1		<1	NA	NA	5.3	5.2	<1	<1	<1	<1

☐ CT&E Data.
NA Not analyzed.
J Result is an estimate.
a Total petroleum hydrocarbons in these water samples exceed the 15 µg/L stated for fresh water in ADEC's Water Quality Criteria 18AAC70 (ADEC 1989).
c Result is indicative of o-xylene only.
d The laboratory reported that the EPH pattern in this sample was not consistent with a middle distillate fuel.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
Matrix: Surface Water
Units: µg/L

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Levels	Environmental Samples				Field Blanks			Lab Blanks
					SW01	SW02	SW03 & SW04 (Duplicates)		AB01	EB02	TB02	
Laboratory Sample ID Numbers					4214-1	4214-2	4209-4 4210-1 4214-3	4209-5 4210-2 4214-4	4209-7 4214-6	4209-6 4214-5	4209-11 4214-7	4209 4210 4214
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Naphthalene	1	1		<1	NA	NA	9.2	10	<1	<1	<1	<1
Toluene	1	1	1,000	<1	NA	NA	5.6	5.7	<1	<1	<1	<1
1,2,4-Trimethylbenzene	1	1		<1	NA	NA	30	31	<1	<1	<1	<1
1,3,5-Trimethylbenzene	1	1		<1	NA	NA	12	13	<1	<1	<1	<1
Xylenes (Total)	2	2	10,000	<2	NA	NA	7.9	8.5	<2	<2	<2	<1
SVOC 8270	10	10		<10	NA	NA	<10J	<10J	NA	<10J	NA	<10
Pesticides	0.05	0.1-1		<0.1-<2	NA	NA	<0.1-<1	NA	NA	NA	NA	<0.1-<1
PCBs	1	1	0.5	<1-<2	NA	NA	<1	NA	NA	NA	NA	<1
TOC	5,000	5,000		6,700-14,400	NA	NA	124,000	82,200	NA	NA	NA	<5,000
TSS	100	200		6,000-9,000	NA	NA	870,000	1,070,000	NA	NA	NA	<100
TDS	10,000	10,000		212,000-352,000	NA	NA	892,000	806,000	NA	NA	NA	<10,000

☐ CT&E Data.
NA Not analyzed.
J Result is an estimate.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples						Field Blank	Lab Blank
					SW03 & SW04 (Duplicates)						EB02	
Laboratory Sample ID Numbers					4210-1	4210-2					4210-3	4210
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L					µg/L	µg/L
Aluminum	17.4	100		<100-350 (<100-340)	10,000 (<100)	17,000 (<100)					<100 (<100)	<100 (<100)
Antimony	N/A	100	6	<100 (<100)	<100 (<100)	<100 (<100)					<100 (<100)	<100 (<100)
Arsenic	5.3	100	50	<100 (<100)	<100 (<100)	<100 (<100)					<100 (<100)	<100 (<100)
Barium	1.2	50	2,000	<50-93 (<50-91)	470 (110)	750 (120)					<50 (<50)	<50 (<50)
Beryllium	N/A	50	4	<50 (<50)	<50 (<50)	<50 (50)					<50 (<50)	<50 (<50)
Cadmium	1.7	50	5	<50 (<50)	<50 (<50)	<50 (50)					<50 (<50)	<50 (<50)
Calcium	34.5	200		4,500-88,000 (4,100-86,000)	120,000 (110,000)	140,000 (111,000)					230 (<200)	<200 (<200)
Chromium	3.29	50	100	<50 (<50)	<50 (<50)	<50 (<50)					<50 (<50)	<50 (<50)
Cobalt	N/A	100		<100 (<100)	<100 (<100)	<100 (<100)					<100 (<100)	<100 (<100)
Copper	2.3	50	1,300	<50 (<50)	240 (<50)	570 (<50)					<50 (<50)	<50 (<50)
Iron	25	100		108-2,800 (<100-1,600)	41,000 (2,900)	64,000 (4,500)					<100 (<100)	792 (792)

☐ CT&E Data.
N/A Not available.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)
Matrix: Surface Water
Units: µg/L
METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples						Field Blank	Lab Blank
					SW03 & SW04 (Duplicates)						EB02	
Laboratory Sample ID Numbers					4210-1	4210-2					4210-3	4210
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L					µg/L	µg/L
Lead	6.6	100	15	<100 (<100)	<100 (<100)	110 (<100)					<100 (<100)	<100 (<100)
Magnesium	47.8	200		<5,000-53,000 (2,600-54,000)	29,000 (27,000)	32,000 (27,000)					<200 (<200)	<200 (<200)
Manganese	1.24	50		<50-510 (<50-120)	2,000 (1,300)	2,500 (1,300)					<50 (<50)	<50 (<50)
Molybdenum	N/A	50		<50 (<50)	<50 (<50)	<50 (<50)					<50 (<50)	<50 (<50)
Nickel	5.5	50	100	<50 (<50)	<50 (<50)	<50 (<50)					<50 (<50)	82 (82)
Potassium	1,154	5,000		<5,000 (<5,000)	13,000 (12,000)	15,000 (13,000)					<5,000 (<5,000)	<5,000 (<5,000)
Selenium	62.4	100	50	<100 (<100)	<100 (<100)	<100 (<100)					<100 (<100)	<100 (<100)
Silver	2.6	50	50	<50 (<50)	<50 (<50)	<50 (<50)					<50 (<50)	<50 (<50)
Sodium	27.7	250		8,400-410,000 (8,200-450,000)	110,000 (126,000)	110,000 (120,000)					570 (500)	250 (<250)
Thallium	0.57	5	2	<5 (<5)	<5 (<5)	<5 (<5)					<5 (<5)	<5 (<5)
Vanadium	1.8	50		<50 (<50)	<50 (<50)	66 (<50)					<50 (<50)	<50 (<50)

☐ CT&E Data.
N/A Not available.

TABLE G-10. OLD SEWAGE AREA PETROLEUM SPILL ANALYTICAL DATA SUMMARY (CONTINUED)

Installation: Oliktok Point
Site: Old Sewage Area Petroleum Spill (SS11)

Matrix: Surface Water
Units: µg/L

METALS ANALYSES: TOTAL (DISSOLVED)

Parameters	Detect. Limits	Quant. Limits	Action Levels	Bkgd. Range from 7 DEW Line Installations	Environmental Samples							Field Blank	Lab Blank
					SW03 & SW04 (Duplicates)							EB02	
Laboratory Sample ID Numbers					4210-1	4210-2						4210-3	4210
ANALYSES	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L						µg/L	µg/L
Zinc	8.2	50		<50-160 (<50)	380 (<50)	840 (<50)						<50 (<50)	<50 (<50)

☐ CT&E Data.
N/A Not available.